7.3 Present Problems of Observation System

Problems on the existing Hydrological and Meteorological Observation system based on field investigation and collected data are summarized as follows:

1) Observation Network

Existing Condition	Problems
- Meteorological	
• 252 raingauging stations Density is around 580 km^2/gauge in an average.	• Density is considered to be insufficient comparing with norm of the WMO (100~250 km^2/gauge).
• The greatest density in the Central next to the Eastern and most sparse in Northern Mountain area in western part.	
• Only 14 stations are equipped with recording raingauges.	• The present gauge number seems to be insufficient from widely located priority project.
- Hydrological	
• 136 water level gauging station Density is around 1100 km^2/gauge in an average.	• Density is considered to be nearly sufficient comparing with norm of WMO (300 1,000 km^2/gauge) however network should be examined with regard to requirement.
• The great density in the middle hill and less density in Terai Plains.	
• 34 stations are equipped with recording water level gauges.	
• 18 sediment discharge stations	• Density is considered to be sufficient comparing with norm of WMO (5~15% of the minimum water level gauging stations) however network should be examined with regard to requirement.

2) Observation items

Existing Condition	Problems
- Meteorological	
14 Aero/Synoptic Station Precipitation, Temperature, Humidity, Wind Velocity/Direction Sunshine duration, Atmospheric pressure	
24 Agrometeorological Station Precipitation, Temperature, Humidity, Wind Velocity/Direction Sunshine duration, Evaporation	
52 Climatological Station Precipitation, Temperature	
149 Precipitation Station (Daily/hourly data)	• No snowfall measurement
- Hydrological	
• Water level (Daily/hourly) • Discharge measurement • Suspended sediment sampling at 18 stations	• No Water Quality observation • No bed load sampling • No particle size analysis and bed material investigation

3) Observation Facilities

Existing Condition	Problems
- Meteorological	
• Ordinary raingauge is U.S. Standard 8 inch precipitation gauge. • Recording raingauges are 7 weighing-type and 7-float and with syphon-type gauges.	• Malfunction of instruments (clock trouble, mechanical trouble etc)
- Hydrological	
• Float-type water level recorder installed in a stilling well is commonly used.	• Most of stilling wells suffer from sedimentation and scouring of river bed blockage of intake pipe during monsoon and well and serious scouring in dry season makes gauge well malfunctional. • Sometimes gauge well is washed out due to enormous flood.

4) Observation method

Existing Condition	Problems
- Meteorological	
• DHM staffs conduct observations at each aero/Synoptic station and part-time observers are employed at other stations.	
• Precipitation observation At precipitation station 1 time/day (8) At others station 2 times/day (8:45, 17:45)	• Inferior data due to inadequate observation such as mis-reading mis-writing, mis-measuring etc.
• Operation Manual prepared by WMO in 1974 is still used.	• It does not meet existing system due to no revision.
- Hydrological	
Water level Part-time gauge readers 3 times/day (8°, 12°, 16°)	
Discharge measurement	
• Following two materials are used: U.S.G.S. Standard Manual Hydrological Observation explained in picture (English and Hindu)	• No Hydrological observation Manual are prepared by DHM
• Usually 2 or 3 times per year by field technicians in R.O. due to budgetary constraints, shortage of trained staff and instruments, poor transportation.	• Number of Discharge Measurement is insufficient comparing with changeable river bed. So, it is difficult to make reliable rating curve. • High flood discharge measurement are scarce.
• No measurement of vertical angles.	• No protractor for vertical angle are provided.
• River section survey are carried out once a year in some stations. • 4 pressure-type water level recorders are operational from 1990 in collaboration with GVS. • Most of discharge measurement facilities consist of single winch cable way.	• Many stations don't provide sufficient cross section. • Around 50 stations provide good rating table out of total 136 stations. • Under monitoring • During high flood, it is very dangerous and difficult to use a heavy sounding weight
Suspended Sediment Sampling	
• Sampling 1 time/day (12°) Almost depth integrated sampling at one vertical section	• Data reliability depends on Sediment characteristics of each river. Generally, point integrated sampling is more accurate and sampling is done at three sections at big scale river.

5) Organization of observation, inspection and maintenance

Existing Condition	Problems
• 30 vacant seats of personnel in R.O. 23 junior Hydro-Meteorological assistants are included.	• Lack of trained technicians.
• Recently, Hydrology and Meteorology were jointed then their works were combined.	•Lack of trained technicians.
• Most of young field engineers don't have no background of both civil engineering and hydrology.	• ditto
• Part-time observers are employed in most stations.	• Disqualified part-time observers due to insufficient training.

6) Inspection and Maintenance

Existing Condition	Problems
• A lot of instruments are remain malfunctional and damaged without repairdue due to lack of spare parts, sufficient trained staff, and budget.	• A lot of damaged instruments become malfunctional. • Lack of recording data
• Very few inspections are conducted.	
• No mechanics and no Work Shop are in R.O.	• No prompt repair works for damaged insruments is impossible.
• No inspection and maintenance manual is provided.	• In Proper repair, maintenance and calibration.

7) Laboratory and instrument Work Shop

Existing Condition	Problems
Laboratory	
• One (1) chemical Laboratory in C.O and Four (4) Sediment Laboratories in R.O.	• Two (2) laboratories are out of order due to malfunction of equipments.
• Suspended Sediment concentration is analyzed.	
Instrument Work Shop	
• Spare parts and spare instruments are insufficient.	• A lot of damaged instruments can not be repaired.
• Two (2) of Hydrological mechanics and Five (5) of meteorological mechanics are employed.	• Mechanics have not taken adequate technical training.
• There are no Work Shop in R.O.	• It takes long time to repair damaged instruments.
• No calibration facility for current meter a few current meter have calibrated in neighboring countries.	• Many current meters have taken no calibration for long years.

8) Education and training

Existing Condition	Problems
• Only high grade Engineers have opportunities to participate technical training programme offered by WMO, UNDP etc.	• It is difficult for field technicians to attend the foreign training programme due to language problems.
• DHM just started their own programme on Hydrometeology for junior Hydro-meteorological assistants.	
• On-the-job training for field technicians are conducted generally.	• Insufficient training.
• A few verbal instructions and for part time observers are conducted.	• Insufficient training.

7.4 Improvement Item and Level

Improvement items and their improvement levels of observation system taken in the Long Term Programme are itemized below. The items and levels are proposed after consideration of the purpose of the Programme, target year, present situation and surrounding condition in future.

(1) Observation

For the items of precipitation and water level, continuous and daily observations are dealt with to assess not only amount but also distribution, intensity or instantaneous peak. Discharge measurement activity is required for every flow condition from drought to flood. Suspended sediment load and bed load material are to be analyzed in the Programme in combination with river survey for sediment transport analysis.

Water quality observation parameters are selected by considering following view points:

1) Observation parameters are chosen in respect of both nationwide environmental aspects and water resources development project for general use.

2) National standard of water quality has not been established and no regular monitoring has been made. So, most common monitoring items, i.e. basic physical and chemical property, basic environmental item and eutrophication item are selected.

   Parameters of physical and chemical property include, Water Temperature, Electrical Conductivity, Turbidity, Chlorine ion.

   Environmental parameters are PH value, Dissolved Oxygen (D.O.), Biochemical Oxygen (BOD), Chemical Oxygen Demand (COD).

   Eutrophication parameters are Nitrogen ammonia, Nitrogen Nitrate, Ortho-Phosphate.

3) From the viewpoints of economic, easy maintenance and minimum requirements, the field simple method such as test kit and portable instrument is recommended.

4) Observation parameter in respect of protection on human health and life is not involved, however necessity of these parameters are to be studied during realization of the Programme.

The network of the above mentioned observation items should fulfill the minimum one to enable nationwide assessment and master planning of water resources projects.

(2) Sediment and Water Quality Analysis

System of sediment and water quality analysis should fulfill the requirement of accurate, timely and economical analysis.

(3) Establishment, Inspection and maintenance of Facility

Establishment, inspection and maintenance of observation facilities are essential and these activities should be performed with proper method and effective schedule.

7.5 Observation

7.5.1 Rainfall Observation

(1) Rainfall Observation Network

The minimum network of rainfall observation is proposed with total 470 stations within the area of Nepal below the altitude of EL. 4,000m in the Long Term Programme considering that:

1) Precipitation is able to be observed in the form of rain below the altitude of EL. 4,000m for more than 6 months in a year. On the contrary, snowfall prevails above the altitude of EL 4,000m. Judging from the purpose of this Project which aims to observe rainfall mainly instead of snowfall, the network is designed in the area below EL. 4,000m. Almost all the villages and towns are also located below EL. 4,000m.

2) Rainfall distribution is rather uniform in the Terai plain and rainfall amount varies widely in mountainous area. Then, density of gauge distribution is determined for each of the above areas conforming to the MWO norm as given below.

Area	Applied density	WMO norm
Terai plain	900 km^2/gauge	600~900 km^2/gauge
Mountainous area	250 km^2/gauge	100~250 km^2/gauge

The density of 250 km^2/gauge in the mountainous area and 900 km^2/gauge in the Terai plain are based on a study result.

The selected 470 raingauge stations, which consist of 252 existing, 14 model and 204 newly proposed stations as seen in Table 7.1, are distributed considering that:

1) All the existing raingauges remain because longer data are more useful and present gauges are in good condition or need only minor repair.

2) New gauges should be distributed uniformly in the northern and southern slopes of ridges on which the monsoon crosses.

3) New gauges should be distributed uniformly following the applied distribution density and representing each altitude.

4) New gauges should be located in or near villages for proper operation and maintenance of the gauge.

The list of the selected 470 raingauge stations is tabulated in Table 7.2 and the network is shown in Fig. 7.1.

Total 60 recording raingauge stations are proposed in the Long Term Programme, which include 14 existing, 14 model observation and 32 newly recommended gauges as shown in Table 7.1. The selection of the recording raingauge stations is made considering that:

1) Gauges should be distributed uniformly with respect to basin area and elevation.

2) At least one gauge should be located in an area in which correlation of rainfall is high each other as seen in Fig. 7.2.

3) Some gauges should be distributed in high rainfall intensity area.

4) Gauges belong to aeronautical, synoptic, agrometeorological and climatological stations for proper and accurate observation and maintenance.

5) According to the Norm of the WMO, at least 10% of raingauges are to be equipped with recorder.

The selected 60 recording raingauges are shown in Fig. 7.2 and 7.3.

(2) Observation Instrument

At present a variety of instruments and techniques have been developed for measuring precipitation. Method of measurement is classified into following two types, i.e. point rainfall measurement and areal rainfall measurement:

1) Point rainfall measurement
   - Non-Recording rainfall gauge (Ordinary raingauge)
   - Recording rainfall gauge
     - Tipping bucket type gauge

- Float with siphon-type gauge
- Weighing-type gauge

2) Area rainfall measurement
   - Rainfall radar
   - Satellite

Rainfall radar might be an effective method of rainfall measurement for flood forecasting and weather forecasting in future to observe location and movement of rainfall area at real time. However, existing rainfall-radar system requires relatively high installation and operation/maintenance cost and has following problems:

1) It is difficult to estimate its quantity of rainfall accurately.
2) Rainfall gauging stations are necessary for calibration of radar indicated rainfall intensities, otherwise error of coefficient of the radar-rainfall equation will increase.
3) Effective radar range is usually 40 to 200 km depending on radar characteristics.
4) Radar indicated rainfall distribution may be different from the actual rain falling on the ground.
5) Stabilized power supply is essential.
6) Specialist is required for operation and maintenance.

Meanwhile, Satellite technique is not direct measurement of rainfall and precipitation is estimated based on brightness of cloud photographs related to rainfall intensities. Problems on this method are 1) accuracy depends on frequency of observation, 2) rain gauging station is necessary for calibration, 3) it takes high cost for observations and 4) a specialist is required.

Therefore, in the Long Term Programme, point rainfall measurement by using Ordinary and Recording gauges is recommended.

Three types of recording rainfall gauges are in general use, i.e. weighing type, tipping bucket type and float with siphon type.

Weighing type is the only satisfactory recording raingauge for recording snowfall directly by water equivalent of snowfall without a heating device. Maintenance is easier and mechanism is simple. Recording period is limited by bucket volume and amount of accumulating rainfall. In hot climate, the amount of liquid precipitation lost through

evaporation a remedy may be the use of an evaporation suppressing liquid such as oil. Another disadvantage is the susceptibility of the weighing mechanism to oscillations initiated gusts of wind.

Tipping bucket type is not suitable for measuring snow without heating the collector. The advantages of this type lies in its simplicity and the digital output of its sensor. The movement of the bucket can be converted into an electric signal so this is specially suited for use at data logger equipment.

The disadvantage of this recording gauge is that small error occurs only in heavy and light rainfall, e.g. lessons during motion of tipping over in heavy rains and evaporation losses in light rains in hot regions. If calibration of the bucket is not complete, accumulating error may be big.

Float with siphon-type may be damaged if the rainfall catches freezes. The heating will affect the accuracy of the observations by increasing evaporation losses. Siphoning mechanism is sensitive and difficult to maintain and operate.

Methods of recording are two main types of charts and digital recording form:

1) The drum chart, short period chart is used i.e. daily, weekly chart.
2) The strip chart (roller type), long period chart is used i.e. weekly, monthly, 3 monthly, yearly chart.
3) Digital recording form, long period record.

   Observation value may be mechanically or electronically converted to digital form and recorded on data logging equipment for later data processing by a computer. Recording period depends on memory size of data logger and accumulating rainfall amount.

Three types of recording gauge, weighing type, tipping bucket type and float with siphon type can be connected with a data logger. Among three type of recording gauge, tipping bucket-type raingauge is suited for use with data logger because of its simplicity and the digital output.

Judging from above mentioned aspects and investigation on operation and maintenance condition of the Model System, following instruments are recommended in the Long Term Programme:

1) Weighing-type gauge with drum chart recorder of one week recording duration is recommended to be installed in the mountainous and hilly areas located above EL 2,000 m, which is approximate possible line of snowfall is winter season.

   (a) This type is the only available recording one which can measure snow fall without a heating device.

   (b) Although this type is sensitive to levellings and friction, periodic check and maintenance makes it function well.

2) Tipping bucket-type with data logger is recommended to be installed in the low land areas located below EL 2,000 m. Selection of this recording gauge is made considering:

   (a) Data processing by using data logger and computer instead of graphic charts shortens time and reduces manpower by omission of abstracting data from graphic charts.

   (b) Data processing by using data logger improves data quality by omission of manual mistakes during abstracting data from charts, tracing data and inputting computer etc.

   (c) Data logging equipment releases observers from complex jobs such as changing recording charts, checking tracing condition of pen or ink and consequently lack of record and doubtful data are reduced.

   (d) Rainfall data to be recorded on the data logger of specific periods such as 10 min. or 20 min. may be useful for special purpose.

To get these advantages of the data logging equipment, the equipment should be kept in good operational condition and be operated correctly by well-trained staff. For safe operation and easy check, it is recommended to equip chart recorder.

Ordinary manual raingauges are also needed to be installed adjacent to respective recording raingauges.

Summary of raingauges and type of recording raingauges to be installed in the Long Term Programme are shown in Table 7.3 and 7.4.

(3) Observation Method

Ordinary raingauge measurement is to be conducted by part-time observers without any change from the present DHM procedure:

1) twice a day at 8:45 and 17:45 in the synoptic, aeronautical, agrometeorological and climatological stations

2) once a day at 8:45 in the other stations

In the recording gauging stations, recording charts are to be replaced by observers once a week. The general check such as appearance/visual inspection and recording status investigation is also to be made at the same time as above.

Digital data stored in data logger are to be collected by field technicians every three months. Operational condition of the data logger is to be checked by them at the time of visit. If that troubles of recording instruments occur, observers must inform DHM Office by earliest way such as telephone.

(4) Observation Staff

A part-time observer is employed at each gauging station at present and this system is proposed to be continued to apply in the Long Term Programme.

Good quality data depend on proper site selection, accurate instruments, proper observation method, collection and processing procedures. So, field activities of observers effect greatly to data quality.

Because qualification of observers is, however, mostly in low level at present, training for them is essential to familiarize with observation technique, to understand importance of accurate observation and to improve data quality.

7.5.2 Water Level Observation

(1) Water Level Observation Network

The minimum network of water level observation is proposed with total 110 stations in the Long Term Programme taking into consideration that:

1) The network should fulfill the minimum hydrological need. Stations are then located at 1) the border with maximum basin area, 2) confluence of major tributaries, 3) topographic change point, 4) downstream of snow and glacier areas, 5) geological fault zone, and 6) rainfall regime changing point.

2) The network should contribute to water usage and control work. Stations are then located near the prospective development projects such as hydropower, irrigation, water supply, flood control, glacial lake burst and soil conservation.

3) The WMO norm recommends the minimum density of 300 to 1,000 km^2/gauge in mountainous area and 1,000 to 2,500 km^2/gauge in flat area such as the Terai plain.

The present condition of the existing water level gauges is summarized in Table 7.5.

The selection of 110 stations is made in Table 7.6. The selected stations include 85 existing, 4 model observation and 21 newly proposed stations. Here, two present priority hydrometric stations, No. 536.2 and No. 640, are discarded due to less need for water resources project and small drainage area. These two stations are revealed to be represented by No. 505 and No. 620. The list of the selected stations for the Long Term Programme and location are shown in Table 7.7 and Fig. 7.4.

Among proposed 110 water level gauging stations, ten stations are selected as basic hydrological stations. The basic hydrological station is:

1) the key station located downstream of the basin and performing accurate and continuous observation with trained staffs and standard instrument, and

2) the base point for water resources development planning and river managing with long-term and accurate records.

The basic stations are as follows:

River Basin	Station No.	Rive Basin	Station No.
Mahakali	150	Gandaki	450
Karnali	280	Bagmati	589
Babai	289.95	Kamala	598
West Rapti	350	Koshi	695
Tinau	390	Kankai	795

The remaining stations are classified into 38 primary stations and 62 secondary stations. The primary stations are selected in order to observe discharge at major tributaries, prospective sites of water resources development projects and near the border with China. The secondary stations are supplemental ones to the primary station.

(2) Observation Instrument

Many different types of continuously recording water level gauges are in use and two types of gauges, float-type and pressure-type gauge, are commonly used.

In Nepal, most of water level gauges are float-type recording gauges installed in gauge wells. However, most gauge wells suffer from sedimentation and scouring of rive bed every year.

In view of this situation, the DHM installed four (4) pressure-type gauges in 1990/1991 in collaboration with the German Development Services and they have monitored operation and maintenance condition.

Commonly Float-type gauges are installed in stilling well, which serves to protect a float from floating debris and suppress fluctuations from surface waves in the stream. Generally, two or three intake pipes are placed from the well into the stream.

Advantages of float-type gauges are easy operation and maintenance and in spite of simple mechanism, high accuracy is kept. However, disadvantages of this type are as follows:

1) This type gauge is subject to blockage of intake pipe and sometimes bottom opening due to serious sediment load, and consequently recording is interrupted.
2) Serious scouring of river bed makes a stilling well malfunctional.
3) Enormous flood such as glacier lake outburst will wash away a stilling well.
4) High cost and long period for construction work of a gauge well.
5) Transportation of construction materials is much difficult in remote area.

Since most intakes are subject to clogging, flushing system or open bottom type of the stilling well are adopted as countermeasures.

On the other hand, pressure-type gauges operate on the principle that pressure at a fixed point in the stream bed is directly proportional to the head of liquid above the point. Advantages of this type are as follows:

1) Easy and short-period installation including construction work.
2) A pressure-type gauge is not sensitive to sediment and can be moved easily in case of great scouring of river and sediment load.

3) Even if a pressure sensor is washed away due to a big flood, a recorder is safe usually and prompt repair is possible.

However, disadvantages of this type are as follows:

1) A sensor is difficult to maintain and repair.

2) Accuracy depends on the total measuring range.

From the view point of fluctuation of river bed and sedimentation, an ultrasonic-type gauge is most preferable one because of no influence of river bed fluctuation. However, this type has problems on accuracy, operation and maintenance, power supply and so on.

Method of recording is two main types of charts and digital recording form as mentioned in the Section for instruments of rainfall observation. Two types of recording gauge, i.e. float-type and pressure-type, can connect with a data logger.

Judging from above mentioned aspects and investigation on operation and maintenance condition of the Model System, following instruments are recommended in the Long Term Programme:

1) The float-type gauge is recommendable because of easy operation and maintenance, and in addition high accuracy at any river stage continuous maintenance such as silt clearance keeps gauge well in good operation.

2) Steel pipe well with core shaped hopper bottom mounted on a vertical rock wall or on a specially constructed pier, which is adjustable river fluctuation is effective to fluctuation of both scouring and silting.

3) In case that it is very difficult to construct gauge well, a pressure-type recording gauge is recommendable from the viewpoint of advantages of easy and short period transportation, construction and installation, easy movement due to riverbed scouring, easy maintenance for silt deposit and so on.

Both of pressure-type and float-type water level gauges are also proposed to be connected with data logging equipment. To get these advantages of the data logger, the equipment should be kept in good operational condition and be operated correctly by well-trained staff. Additionally, for smooth safe operation it is recommended that data logger provides a function indicating any troubles against an emergency. For example, part time observer checks the display equipped with the gauge every day and then can find some troubles from discrepancy between actual values observed from staff gauge and values shown on the

display. If a observer finds some troubles with the data logger, he/she must inform the DHM office by earliest way.

Anyway installation of water level gauge is very difficult in Nepal and both types of water level gauges have advantages and disadvantages. Study on selection of recording water level gauge should be reviewed in each future stage.

Type of recording water level gauges to be installed in the Long-Term Programme is shown in Table 7.8.

(3) Observation Staff

Part-time observers such as gauge readers, winch operators, sediment collector, bottle runner are now employed by the DHM. For the Long Term Programme the following staffs are recommended to be employed:

1) Part-time observers are continued to be employed.

2) In the basic hydrological stations, it is recommended to assign two (2) DHM staffs, one Junior Hydrometeorological Assistant and one Field Assistant, and make them stay in a whole year so as to conduct sufficient, effective and accurate observation and maintain the station in best condition.

(4) Observation Method

Not only regular observations at the same time every day but also more frequent observations are desirable for hydrological purposes during flood periods.

The following methods are proposed in the Long Term Programme:

1) Staff gauge reading is to be conducted by observers three times at 8:00, 12:00 and 16:00 every day. In addition to this regular reading, temporary staff gauge reading of flood is recommended including every hour reading of staff gauge during the period that the water level is higher than the specified level and observation of slope of water surface.
2) In the recording gauging stations, recording charts are to be replaced once a week and simple check of instruments and facilities is to be made at the same time as above. Digital data stored in data logger are to be collected by field technicians at the time of discharge measurements and inspection. Operational condition of data logger is to be checked by part-time observers everyday. In case that troubles of recording gauge occur, hourly measurement should be started by observers. Observers will have to write down present condition of instruments and facilities in the observation note book and inform troubles of instruments and facilities to DHM by earliest way.

7.5.3 Discharge Measurement

(1) Measurement Instrument

At present, the discharge measurements are carried out by current metering method and price type current meter is used at almost discharge gauging stations in Nepal. Tracer technique is utilized in the high mountainous stations of the Snow and Glacier Hydrology Project.

Two types of current meters, price-type and propeller-type, are in common use. Price-type is normally very sturdy and easily maintained. However, it is more prone to error in metering turbulent flow. On the other hand, Propeller-type is better suited to the river with turbulent and shifting streams.

Almost rivers in mountainous areas in Nepal are turbulent and shifting flow. Therefore in these area propeller-type current meter is recommended.

Single drum winch cable way with a cable car is in common use in Nepal. This system is very mechanically simple and economical due to domestic production, and has easy maintenance and operation.

On the other hand, double drum winch cable way applied for bank operating system has the advantages of safe discharge measurement and easy handling of a heavy weight during flood measurements. However, installation cost is very expensive and so as to keep in good operation condition careful maintenance should be required.

In the Long Term Programme, then the following instruments are recommended:

1) Twenty five (25) propeller-type current meters are to be provided, ten (10) in the basic stations and fifteen (15) in the Basin Office and sounding weight should be kept in remote hydrometric stations. Protection of a propeller against attack by boulder and driftwood is to be considered.

2) Fifteen (15) price-type current meters are to be provided. This type current meter is used for single drum winch cable way with cable car in the gentle river through plain areas.

3) Thirty two (32) bank-operating double drum winch cable ways are to be installed, seven (7) in the basic hydrological stations and twenty five (25) in the primary stations located in mountainous area.

   Gasoline operated winch available for extremely heavy weight is recommended in extremely deep and wide rivers.

4) Single drum winch cable ways with cable car are to be installed in 2 primary stations located in Terai and Siwalik area and 25 secondary stations except 15 to be repaired, 13 in good operation and nine (9) near Indian border.

5) Current meter measurements from boats are recommended at the station which is not equipped with a cable way near Indian border.

6) For high flood measurements such as float-method by measuring passing time of float and slope-area method, additional two sets of staff gauges are proposed in the basic and primary stations.

7) For high flood measurements, peak water level gauges are proposed in all the secondary stations.

(2) Observation Staff

Considering the present condition of low measurement frequency and lack of flood discharge measurement in most gauging stations, not only measuring method but also present measuring schedule and organization should be reviewed. For the Long Term Programme the followings are examined to improve discharge measurement activities:

1) Efficient discharge measurement schedule by stationed technical staffs during the monsoon season.

2) Continuous discharge measurements in the basic hydrological stations by the full-time technical staffs.

3) High flood measurement by using float-method with 5 persons as follows:

One (1) Group leader	All direction concerning the measurement and all responsibility for safety
One (1) Float man	Lowers floats into water
One (1) First observer	Signals to second observer when the floats pass the first observation line
One (1) Second observer	Measures the time
One (1) Water level man	Measures the water level during measurement period

4) Slope-area measurement during floods by part-time observers.

(3) Observation Method

The discharge measurement is mainly conducted by using current meters. The standard method and proper procedure are now applied to the current metering measurement by the DHM, though angle correction, which is requisite, is not done in almost gauging stations.

The float method and slope-area measurement are recommended during high floods only when it is difficult to employ a current meter. Outline of these two methods is explained below:

1) Float method

Two cross sections are selected along the river. Upstream the beginning section, surface floats or rod floats are fallen and passing time is measured between the beginning and end sections. From the passing time and the cross section area, river discharge can be obtained. The float velocity is multiplied by a coefficient which is based on the shape of the vertical velocity profile and relative depth of immersion of the float.

2) Slope-area method

This is one of the most common types of indirect measurement. Discharge is computed on the basis of an uniform-flow equation such as the Manning equation or non-uniform flow equation involving channel characteristics, water-surface profiles and a roughness coefficient.

The following items are proposed in the Long Term Programme:

1) Improvement of the current metering method such as angle correction, the proper procedure and so on.

2) Introduction of high flood measurements such as float method and slope-area measurement.

Basically, the number of discharge measurements at a stream gauging station should be adequate to define the rating curve throughout entire range of stages.

Considering the WMO recommendation of a minimum of ten (10) discharge measurements per year and importance of stations, following are proposed in the Long Term Programme:

1) In the basic stations, regular bi-weekly discharge measurement in dry season and weekly discharge measurement in monsoon season are recommended. Additionally, temporary high flood measurements are required. A total minimum of thirty six (36) discharge measurements per year are recommended.

2) In the primary stations, a minimum of ten (10) discharge measurements per year are recommended. Also temporary high flood measurements are required.

3) In the secondary stations, a minimum of six (6) discharge measurements per year are recommended. Also temporary high flood measurements are required.

It is needless to say that not only the number of discharge measurements but also distribution of discharge measurements is to be considered to define the stage-discharge relation throughout the entire range of stage.

Since discharge measurements during floods are very important, it is recommended that the measurement programme provides for non-routine discharge measurement and at newly established stations more discharge measurements are scheduled.

7.5.4 Sediment Observation

(1) Sediment Observation Network

Twenty (20) stations are selected and proposed as stations of the sediment sampling network for the Long Term Programme from the following points:

1) the network includes all the basic hydrological stations,

2) sampling should be made at the stations of which upstream basins are less forested and heavily eroded (Station No. 270, 410, 439.7, 445, 447, 670, 680, 690), and,

3) sampling should be made at the prospective water resources development project sites (Station No. 240, 600.1)

(2) Observation Instrument

For sampling of suspended sediment, two types of samplers i.e. point integration sampler and depth integration one, are proposed to be used in the sediment sampling stations.

Type of a sampler should be selected to meet data collection requirement with due consideration of suitable measuring methods, sampling depth and volume and sampler weight.

Turbidity is one of indirect methods of sediment concentration measurement. Turbidity meter is commonly used for measuring turbidity. This method is convenient to the field job which does not need transportation of heavy sampling bottles.

For sampling of suspended sediment and river bed materials, the following instruments are recommended to be installed in the Long Term Programme:

1) Ten (10) point integrated samplers to be installed in the basic hydrological stations (Point integrated sampling is carried out at No. 150 and No. 280)
2) Five (5) depth integrated samplers to be installed in other sediment sampling stations.
3) Five (5) sets of pit sampling apparatus for sampling of undisturbed river bed materials.
4) Ten (10) turbidity meters to be installed in the basic hydrological stations and Station No. 550.05.

(3) Observation Staff

Sampling of the suspended sediment and riverbed material is to be carried out by part-time observers of the water level gauge or the staffs of the DHM in the basic hydrological station regularly. Field technicians are better to take sediment sampling at the time of site visit for discharge measurement .

(4) Sampling Method

1) Suspended sediment

Conventional methods used to measure suspended sediment concentration in a vertical are sampling by point integration or depth integration.

In point integration method, sampling is taken at the points which are decided on the basis of the depth of the river, the grain size of the suspended sediment and the shape of distribution curve.

Commonly, simplified methods are: (a) One point at depth 0.5 or 0.6 (b) Two points, at relative depth 0.2 and 0.8 (c) Three points, at relative depth 0.2, 0.5 and 0.8. Three methods should be adapted after examination by multipoint or other more accurate methods.

On the other hand, in depth integration method sampling is taken in continuously while the sampler is moving at a constant transient rate along the vertical. The sediment concentration of the sample should be representative of the average concentration in the vertical.

Commonly sediment concentration is determined by weighing the dried sediment contained in the sample and dividing by the volume of sediment water mixture of the sample. One of the indirect methods, which have been used in some countries, is measuring a certain turbidity unit to obtain the sediment concentration from the calibration curve expressing the relationship between the turbidity unit and the sediment concentration.

Generally, turbidity is measured as the ratio of the intensity of the light scattered by the suspended sediment particles to the intensity of light transmitted through the light. Particle size of sediment materials effects the intensity of light so attention must be paid to variation in sediment particles.

Since transportation of a lot of sampling bottles is one of annoying problems, the convenient field measurement of turbidity is one of the effective methods.

Basically the number of verticals for suspended sediment sampling depends on the size distribution and concentration distribution of the sediment across the entire section of a stream as well as on desired accuracy of data. There are no definite and reliable rules for the selection of measurements. A lesser number of verticals are usually used for measurement during flood to shorten the duration of sampling.

A sufficient number of sediment measurements should be made during floods because sediment flow will be concentrated in the flood season and in large floods.

The following are proposed as the sampling method to be involved in the Long Term Programme:

	Present Method	Improvement of Method
Sampling Method	depth integrated sampling	(1) Point integrated method, sampling of two points at depth 0.2 and 0.8 or one point at depth 0.6 in basic stations (2) Depth integrated method in other sampling stations (3) Indirect field measurement using a turbidity meter in basic stations
Discharge Measurement	no	necessary for point integrated sampling
Measuring Section	one (1) vertical section or near river bank	(1) Three (3) verticals such as one in the main current and two on both sides. (2) One (1) vertical located near the main current during floods.
Frequency	once/day	Regular measurement, once a week during dry season and once a day during monsoon season
Flood Measurement	no	Hourly sampling during floods

2) River bed material sampling

Disturbed and/or undisturbed samples are obtained by various means.

Sampling equipments such as the Axile type, cylindrical revolving type, vibration type are used for undisturbed samples of fine and soft river bed materials in the streams and reservoir and also in exposed river bed. While, in mountainous area the pit method is suitable and is recommended because of economical and simple one. When the samples are taken on flood plain, the number of sampling points depends upon the width of deposits over the flood plain and the variation in bed material sizes.

The WMO recommends minimum number of sampling points on a random layout:

Width of main channel in m	:	< 500m	500-1000m	>1000m
Minimum number of sampling points	:	3	3-5	5-7

Sampling section is taken along the section of discharge measurement.

It is recommended that sampling of river bed material is made at least once a year in all sediment observation stations.

3) River profile/cross section survey

Area of river survey is proposed between 1km upstream from the discharge measurement section and 1km downstream from the station with interval of spacing

approximately 200m. It is recommended that river survey is made once a year in representative sediment observation stations located in mountainous areas.

7.5.5 Water Quality Observation

(1) Water Quality Observation Network

For the initial stage of the water quality observation which has not yet done by the DHM, observation at eleven (11) stations is recommended in the Long Term Programme to collect nationwide and general data on river water quality. They are ten (10) basic hydrological stations and Station No. 550.05.

(2) Detail Observation Item

As stated in 7.4, following eleven (11) parameters are chosen in respect of environmental aspects and water resources and necessity of analysis on parameters in respect of protection on human health and life are to be studied in the Programme.

(a) Water Temperature

Water temperature effects many processes important to aquatic environment and influences aquatic life (flora and fauna) in lakes and streams. Thus water temperature is important parameter not only as an important property of water in itself, but also because it is a variable in several of the other parameters measured in the field.

(b) PH-value

The PH is measured of the acidity or alkalinity of a solution. Neutral solutions have a PH of 7, acid solutions a PH of less than 7 and alkaline solutions a PH greater than 7. The PH value of natural waters usually lies within the range 5 to 8.6 units.

Change in PH is caused by acid rain, industrial wastes, mine drainage water or leaching of minerals. The PH is an important criterion of the quality of water because it affects the viability of aquatic life and many uses of water.

(c) Electrical Conductivity

Conductivity measures water's ability to conduct an electric current and depends on the concentration of ions in solution. The relationship between conductivity and the concentration of dissolved solids is approximately constant for most natural water, therefore changes in conductivity can indicate saline intrusion and other source of pollution.

(d) Dissolved Oxygen (DO)

The presence of dissolved Oxygen in lakes and rivers is vital for the survival of aquatic life. If the water course suffers from lack of dissolved Oxygen, aquatic life ceases and the natural purifying capacity of the water course also ceases with a consequent further deterioration in water quality. Amounts of dissolved Oxygen below 5mg/liter are considered insufficient for the life of many aquatic organisms.

Therefore, the dissolved Oxygen concentration is important for the evaluation of overall water quality and of water treatment process control.

(e) Nitrogen Ammonia (NH_4-N)

The presence of ammonia in streams and lakes is usually connected with the process of biochemical decomposition of protein substances found in industrial sewage and chemical fertilizers.

Ammonia indicates very recent organic pollution from sewage, industry or breeding.

(f) Nitrogen Nitrate (NO_2-N)

Nitrates are the end product of the biochemical oxidation of ammonia. Increased concentrations of nitrates may indicate faecal pollution of the water.

Information on changes in the concentration of nitrates may be used to characterize the self-purifying capacity of the water body.

(g) Ortho-Phosphate

The presence of phosphate is due to the use of fertilizers in agriculture and from sewage. High contents of nitrate and phosphates in rivers or lakes stimulate the growth of aquatic flora beyond the capacity. In case that a process of decomposition being and it can cause the total consumption of the dissolved oxygen, the plants and the animals may die.

(h) Turbidity

Water turbidity can be measured by the scattering of light by undissolved substances. Water turbidity may be caused by clay, silt or mud stirred up by flash flood or torrential flow and can be generated by mining or industrial wastes, by the formation of metal oxides such as iron or manganese and by leading of humic substances or growth of microbiota.

The turbidity of water sample is a measure of the ability of suspended and colloidal materials, which are measured as the dried weight of particles. However, turbidity is not simply a function of the amount of material present, since particle size is an important factor.

(i) Chlorine Ion

Sewage and some industrial drainage contain chlorine ion and its value becomes bigger with the increase of degree of pollution.

(j) Biochemical Oxygen Demand in 5 days (BOD)

The amount of dissolved oxygen consumed by a certain volume of a sample of water for the process of biochemical oxidation during a period of five days at 20°C has been established as the Biochemical Oxygen Demand (BOD) test.

This is a measure of the amount of biodegradable matter present in the water. Effluents with high BOD values may reduce the Oxygen concentration of the receiving water body below the level necessary to enable the life of the aquatic organisms. High BOD values indicate organic pollution.

However the predications of the effects of Biochemical Oxidation in streams or lakes are more complicated and may involve many other factors not involved in the determination of BOD.

(k) Chemical Oxygen Demand (COD)

This is the total amount of Oxygen required to oxidize the organic matter present in the water by using a strong chemical oxidants. High COD values indicate pollution from sewage and industrial waste water.

(3) Observation Instrument

In the Long Term Programme following observation instruments are recommended:

1) Test kits applied for colorimetric analysis are proposed to be used for measurement of Nitrogen Ammonia, Nitrogen Nitrate, Ortho-Phosphate and Chlorine Ion in water quality.

2) Portable probes applied for electrode method are proposed to be used for measurement of Water Temperature, PH-value, Conductivity, Dissolved Oxygen and Turbidity which are to be installed at each basic station.

3) Containers for transporting samples of BOD and COD are to be provided.

(4) Observation Staff

The water quality observation will be carried out by:

1) Technical staffs, who will stay continuously in the basic hydrological stations and take routine water quality observation such as water temperature, PH-value, conductivity, dissolved oxygen and turbidity every day,

2) Laboratory staffs, who will work in the water quality laboratory of Basin Office and take field water quality observation such as nitrogen ammonia, nitrogen nitrate, ortho-phosphate, and chlorine ion and sampling for BOD and COD once a month.

Technical training is important for the observation staffs.

(5) Observation Method

Almost all water quality parameters are preferable and available for field measurements except BOD and COD. Colorimetric analysis by test kits and electrode method by portable measuring equipments (probe) are recommended for convenient field measurements.

The collection of depth-integrated samples in a single vertical is recommended.

The samples of BOD and COD must be transported to the laboratory within 24 hours after sampling and be kept at a temperature of 3° to 4°C to slow down the biochemical oxidation processes.

Routine observations are recommended with the following frequency:

1) Daily observation parameters

Water temperature, Ph-value, conductivity, dissolved oxygen (DO) and turbidity

2) Monthly observation parameters

Nitrogen Ammonia, Nitrogen Nitrate, Ortho-phosphate, Chlorine ion, BOD and COD.

7.6 Sediment and Water Quality Analysis

7.6.1 Sediment Analysis

1) Suspended sediment analysis

Commonly, evaporation, filtration or displacement methods are used in a laboratory to determine the suspended sediment concentration. In general, the evaporation method is suitable for use with low concentration. The filtration method may be used for samples of medium and high concentrations. The displace method, however, is suitable only for high concentration. The evaporation method which the DHM mainly uses and the filtration method are recommended.

2) Particle size analysis

There are many methods available for size analysis. However, each method can only be applied in a specific size range. The methods based on the setting principle is recommended to obtain the setting diameter and the setting velocity.

So, following two methods are recommended to analyze the whole sediments sample:

(a) Visual accumulation (VA) method for sizes 0.062 to 2.0mm or sieve method, and

(b) Hydrometer method for sizes 0.005 to 0.05mm.

Size graduation curve, setting velocity and specific gravity are analyzed.

3) Analysis of river bed material

Sieve analysis and some physical properties of river bed materials such as Specific Gravity and Unit weight (Percentage of void) are also important for sediment study.

For the proper and efficient sediment analysis the followings are to be included in the Long Term Programme:

(a) Repair and Strengthen existing laboratory equipments such as electric oven and balance etc.

(b) Introduction of new analysis items such as particle size analysis of suspended sediment and analysis of river bed material.

(c) Guidance of proper sediment analysis by foreign experts and preparation of procedure manual.

7.6.2 Water Quality Analysis

(1) Water quality analysis

Most of water quality parameters are measured in the field. Only samples for BOD and COD are transported and analyzed in the laboratory. A BOD meter, a COD meter and an incubator etc. are to be installed in the Water Quality Laboratory.

The following activities are to be scheduled in the Long Term Programme:

1) Preparation of Laboratory space and equipments such as BOD meter, COD meter and incubator in the Central and Eastern Laboratory.
2) Test kits for the field measurements in each Regional Laboratory.
3) Guidance of proper analysis by foreign experts and preparation of procedure manual.

(2) Sediment and Water Quality Laboratory

Strengthening of activity of sediment analysis and introducing of water quality analysis are recommended to be included in the Long Term Programme. The laboratories for the above analysis are considered as follows:

1) The existing sediment laboratories in the Central Office in Kathmandu and the Regional Offices are to be strengthened and expanded.
2) The water quality laboratory is to be newly established in the strengthened sediment laboratories in the Central and the Basin Offices.
3) In each Basin sediment and water quality laboratory, two (2) DHM staffs, one laboratory Chief and one Assistant, are to be assigned.

(3) Tracer Laboratory

A tracer laboratory has been operated in Kathmandu under the Snow and Glacier Hydrology Project. The tracer technique is one of the effective discharge measurement methods for turbulent flow in the mountainous area. Hence it is recommended to continue the operation of this tracer laboratory.

7.7 Establishment, Inspection and Maintenance of Facility

7.7.1 Establishment of Station

Establishment work of gauging stations and laboratories consists of network design, selection of instrument, structural design, civil construction work and its supervision. The Establishment System includes structural design, civil construction work, instrument installation and their supervision. The network design and instrument selection will be conducted in the Data Quality Research System which will be discussed in the following Section.

In the Programme, the Establishment System is to be strengthened. The Establishment System will function in the Basin Office and technical staffs of the Basin Office take the responsibility of structural design and construction/installation works.

7.7.2 Inspection and Maintenance in Basin Office

(1) General

Frequent inspection and continuous maintenance are essential for maintaining good quality observation.

The INSPECTION is the most basic item and is important to know current condition of instruments and facilities and previously to prevent the possibility of system failures.
The maintenance is classified into ADJUSTMENT and REPAIR.

The ADJUSTMENT is required for the equipment which shows a measured value exceeding a standard value at the time of inspection. Regular calibration is recommended for specific equipments.

Immediate REPAIR is required after finding any faults. In most cases the fault should be removed by replacing the defected component with spare parts. To shorten time for restoration should be considered principally. Proper and prompt maintenance requires complete procedure manual on maintenance.

Inspection and maintenance of meteorological and hydrometric station are in charge of the Basin Office.

(2) Facilities to be maintained

Following instruments and facilities are required to be maintained:

Precipitation gauging station
- Ordinary rainfall gauge
- Recording rainfall gauge
- Data logger
- Others

Water level gauging discharge measurement station
- Staff gauge
- Recording water level gauge
- Data logger
- Current meter with accessories
- Water level gauge well with surrounding structures
- Cable way facilities (winch, cable wire, other structures)
- Others

Sediment sampling station
- Sediment sampler
- Sampling bottles
- Others

Water quality observation station
- Portable meter with electrodes method
- Test apparatus for sampling
- Others

(3) Inspection method

Two inspections, daily/weekly inspection and three monthly/annual inspection are proposed. The former consists of general checking by part-time observers. The latter is required to be performed closer by well trained technicians. Both of inspections are very important for good operation of the system.

In addition to above routine inspections, immediately after every severe flood non-routine inspections are required to check the stability of observation station.

1) Daily/weekly inspection

Daily/weekly inspection items consist of:

(a) Appearance/Visual inspection of instruments and facilities

(b) Recording status checking

(c) Data comparison between recording and manual measurement

(d) Replacement of recording paper, ink and so on

2) Three Monthly/Annual Inspection

Three Monthly inspection shall be conducted by both field technicians and mechanical technicians. Mechanical technicians mainly inspect condition of recording instruments and mechanical facilities.

Inspection items by field technicians consist of:

(a) Closer daily/weekly inspection

(b) Stretch cable wire, clearance of sediment in gauge well, as required

(c) Check bench mark and stability of staff gauges

(d) Make minor field repairs and adjustments of instruments and facilities as required

(e) Check any changes in the observation site (e.g. trees affecting raingauge, change river course etc)

(f) Check the observer's records

(g) Check sufficient recording forms, recording charts, cartridge pen and other supplies.

(h) Make local arrangement for improvement of the site, as required

(i) Instruct or advise the observers, as required

(j) Training and education for the observers

Meanwhile, inspection items by mechanical technicians consist of:

(a) Mechanical inspection for instruments

(b) Electrical inspection for instruments including battery replacement

(c) Field repairs and adjustments of instruments, as required

For overall checking, annual inspection by the Hydrologist/Meteorogist is important and to be scheduled on basis of inspection results by field technicians and degree of importance.

Manual and Inspection record form are required for all field inspections. Records the condition, details of the fault and action is efficient for future maintenance.

(4) Adjustment and Calibration

Minor adjustment may be performed by observers or field technicians. Adjustment and calibration for some specific instruments and facilities such as rainfall recorder, water level recorder, data logger, winch and portable meter for water quality observation and so on shall be conducted by well-trained mechanical technicians once a year.

Regular calibration of current meter is required urgently. Damaged or unreliable current meter shall be calibrated immediately.

(5) Repair

In most cases, the fault should be removed by replacing the defected component with a spare one. Therefore, the quantity of the spare parts shall always be confirmed and be sure to replenish good spare parts if any defective components are found. The repair work and storing of spares are to be done at the workshop to be established in the Basin Offices.

Complete repair cannot always be expected by the well-trained technician, so it is better to keep sufficient spare instruments.

(6) Staff and Schedule for Inspection and Maintenance

In order to keep good operational condition of instruments and facilities in remote areas, not only patrol by trained technicians but also general checking by part-time observers is very effective. Immediate information by the observer's inspection must be useful for future inspection by field technicians and shorten the restoration time. It is proposed to establish the workshop in each Basin Office for quick repair and proper management of instruments. Recommended maintenance schedule of precipitation hydrometric stations is shown in Table 7.9 and 7.10.

The following staff and schedule are proposed in the Long Term Programme:

1) The daily/weekly inspection, which is general checking, is required to be performed by the part-time observers. The weekly inspection is to be made at each recording

station at the changing time of recording chart. In the basic hydrological stations, stationed DHM staffs should inspect all instruments and facilities.

2) The three monthly inspection is to be made by the well trained field technicians. Workshop mechanics also should carry out periodic inspection for recording stations. A field technician is better to conduct inspection at the time of discharge measurements.

3) The annual inspection for overall checking of stations is required by the Hydrologist and Meteorologist.

4) The adjustment and calibration of instruments are to be conducted by well trained workshop mechanics regularly.

5) In each workshop in each Basin Office, two (2) mechanics (chief and assistant) are to be employed.

(7) Instrument Workshop in Basin Office

Besides the existing workshop in the Central Office, instrument workshop in each Basin Office is recommended to be established in the Long Term Programme. This workshop will be effective to control and manage efficiently all the instruments of the Basin Office and to shorten repair time.

To establish the workshop in each Basin Office, the following items should be studied:

1) Two (2) mechanics (chief and assistant) are to be employed.

2) Preparation of workshop space, repair equipments and tools.

3) Supply of sufficient spare parts and spare instruments.

4) Technical training for maintenance and repair of instruments and Manuals.

7.7.3 Inspection and Maintenance in Central Office

(1) General

Good and effective communication between the Central Office and each Basin Office is very important. The Central Workshop shall give proper and timely advice and suggestion to the Basin Workshop and it is recommended that each Basin Workshop informs activities and condition of all stations every year. As required, staffs of the Central Office carry out field inspection and discuss with staffs of the Basin Office.

(2) Instrument Workshop in Central Office

Existing instrument workshop in the Central Office is not effectively functional because of lack of spare parts and tools, insufficient budget and shortage of well-trained technicians. Therefore, followings are proposed in the Long Term Programme:

1) Repair and reinforcement of the existing repair machines and tools
2) Supply of sufficient spare parts and spare instruments
3) Practical training for mechanical and electrical maintenance and repair of instruments by manufactures
4) Reinforcement of staffs such as electric technicians

(3) Calibration Facility for a Current Meter

All calibrations for a current meter have been ordered to Foreign official facilities in neighbouring countries e.g. India, Thailand since there is no calibration facility in Nepal. However, calibration is not done regularly and its frequency is scarce due to lack of budget of the DHM and management. In 1993, a small scale calibration tank, which can be calibrated up to about 1.7m/sec, will be constructed in JICA Water Induced Disaster Prevention Technical Center and staff training programme is planned.

In the Long Term Programme, full fledged standard current meter calibration facility is recommended to be established as following reasons:

1) Calibrated current meter is essential for accurate discharge measurements.
2) Current meter is subject to be damaged by attack of boulders in mountainous steep rivers with turbulent and rapid flow velocity, where river bed materials consist of big boulders.
3) Above-mentioned calibration tank constructed in JICA Water Induced Disaster Prevention Technical Center is too small to carry out sufficient calibration test.
4) There are no sufficient calibration facility in neighbouring countries e.g. up to 4.5m/sec in India or up to 2.5 m/sec in Thailand.

Skill and well trained technicians are essential to operate calibration facility properly and maintain in good condition, therefore foreign experts are necessary to give technical guidance and training to technicians.

Summary of Observation System in Long-Term Programme are shown in Table 7.11.

7.8 Organization and Staff

7.8.1 Organization of DHM

(1) General

In the Long-Term Programme, new Observation and Data Management System is to be proposed. To operate these systems, new organization is to be studied.

The DHM will consist of one Central Office, four Basin Offices, ten Branch Offices, ten Basic Stations and fourteen synoptic stations. Among these ten Branch Offices, four Branch Offices will also work for synoptic stations. Because they will be established at the same site with these synoptic stations.

The synoptic stations and Basic Stations will observe maintain a station, preliminary data check and send data to Basin Offices. The Branch Office will maintain stations, collect data, check them preliminarily instruct observers observe and sent data to Basin Offices. The Branch office will maintain stations, collect data, observe, instruct observer, enter and process data including data checking work and send data to the Central office. The Central Office will manage system, store data, disseminate data, train staffs and analyse.

(2) Central Office

The Central Office will consist of two divisions, the Data Management division and Evaluation division.

1) Data Management Section

This division consists of two sections which are Management Section and Data Arrangement Section. Under Management Section Progress Control Unit and Quality Control Unit. Trainign Center, Central Woskhop and Central Laboratory are belong to Quality Control Unit.

(a) Central Instrument Workshop

Workshop will be divided into Meteorological Instrument Workshop and Hydrological one. Calibration facility belongs to Hydrological Instrument workshop.

(b) Central Sediment/Water Quality Laboratory

Laboratory will be divided into Sediment Laboratory and Water Quality Laboratory. This will work for Sampling by Central Basin office.

2) Evaluation Division

This Division will evaluate system from the outsider's viewpoint. It will dialogue with users to improve system.

(3) Basin Office

Four (4) Basin Offices of Far Western Basin Office at Nepalgunj, Western Basin Office at Pokhara, Central Basin Office at Kathmandu and Eastern Basin Office at Biratnagar will be established to maintain stations, instruct observers, measure discharge, collect data, enter data, process data and send them to the Central Office. The Basin Office will consist of Data Arrangement Unit, Observation Unit, Laboratory Unit and Workshop.

a) Observation Unit

Observation Unit will operate, maintain ordinary stations and instruct observers of ordinary stations.

(4) Branch Office

Ten (10) Branch Offices will be established in the northern part of Nepal to observe, maintain stations and instruct observers and send the result to the Basin Office.

The place for these Branch Offices will be at Bangga, Chainpur, Simikot, Jumula and Mushikot under Far Western Basin Office, Jomsom under Western Basin Office, Simara under Central Basin Office, Okhaldunga, Khandbari and Taplejun under Eastern Basin Office.

(5) Basic Station

Ten (10) Basic Stations will be established in Mahakali, Karnali, Babai, West Rapti, Tinau, Gandaki, Bagmati, Kamala, Koshi and Kankai River basins to get most reliable data by stationed DHM staffs.

(6) Synoptic Station

Synoptic Stations have been already installed by the DHM to observe meteorological data such as precipitation, temperature, humidity, wind and so forth by stationed DHM staffs.

(7) Ordinary Station

Part-time observers employed by DHM operate and maintain meteorological and hydrological data such as precipitation and water level and so forth.

The proposed organization as above is shown in Fig. 7.4. Number of Observation Station in charge of Basin Office is shown in Table 7.12.

Appropriate personnel and organization is essential for the system, additionally , Clarifying their tasks and responsibility makes the system function well and smoothly. Tasks of each section related to observation system are described below:

(a) Design Unit in Evaluation Divison

- Network design including establishment and cancel of stations
- Design of the civil construction works such as a gauge well, cable way, anchor block, protection wall etc.
- Selection of instruments and equipments
- Study on new technology of observation system
- Preparation and Review of Operation/Maintenance Manuals

(b) Instrument workshop in Central Office

- Repair of meteorological and hydrological instruments, if workshop in the Basin office can not repair.
- Periodic and Occasional Calibration/adjustment of specific meteorological and hydrological instruments
- Arrangement of repair order abroad if required
- Grasp on working condition of the instruments on the basis of information from the Basin office
- Management of spare parts and spare instruments
- Technical support to Workshop in the Basin office
- Design and Manufacture of spare parts available in Nepal
- Calibration of current meter by using proposed calibration facilities and operate and manage the facility
- Study on new technology instruments

- Practical mechanical, electronic and electronical training to the Basin Office

(c) Laboratory in Central Office

Laboratory will be divided into Sediment Laboratory and Water Quality Laboratory though water quality observation was start in the Second Stage, Preliminary Water quality observation was started from 1993 by DHM collaborated with GDS.

- Sediment analysis in charge of Central Basin Office
- Special Sediment Observation
- Grasp on working condition of the sampling stations
- Technical support to Laboratory in the Basin Office
- Maintenance of Laboratory Instrument
- Calculational of sediment concentration

(d) Observation Unit in Basin Office

- Field Observation such as discharge measurements, sediment sampling, survey and son on.
- Inspection of observation stations and reporting the results
- Supervision of civil construction works for establishment or repair of observation stations
- Minor repair of instruments and facilities
- Instruction and training of part-time observes
- Collection of records and charts, supply of consumables such as charts, pen and data format
- Delivery of observer's salary
- Design and cost estimation of minor repair works
- Grasp on working condition of all the stations and completion of station inventory

(e) Instrument Workshop in Basin Office

- Inspection of the Instrument and reporting the results

- Grasp on working condition of all instruments and preparation of instrument inventory and update
- Periodic and occasional calibration of the instruments
- Repair of the instruments
- Stock of sufficient quantity of spare parts and spare instruments

(f) Laboratory in Basin Office

- Sediment analysis
- Maintenance of laboratory equipments
- Preliminary Calculation of sediment concentration
- Grasp of working condition of the sampling stations

(g) Basic hydrological Station

- Field observation such as water level frequent discharge measurements including flood measurements
- Inspection and Maintenance of instruments and facilities and reporting the results
- Data collection, preliminary processing and transportation
- All the management concerning the basic station

(h) Synoptic Station

- Meteorological observations such as precipitation, temperature, humidity, wind velocity and direction and so on.
- Inspection of the instrument and facility and reporting the results
- Data collection preliminary processing and transportation by both wireless and Post office
- Minor repair and maintenance of the station

(i) Ordinary Station

- Hydrological and meteorological observation such as water level, precipitation and so on

- Daily/Weekly inspection of the instruments and facilities
- Maintenance of the station

7.8.2 Staffing

(a) Instrument Workshop in the Central Office

One chief and four technical staffs will be sufficient. One electronic technical is required. A Technician should repair and calibrate both hydrological and meteorological instruments Calibration of current meter is conducted by this unit.

(b) Laboratory in the Central Office

One Chief and four technical staffs will be sufficient. Two are in charge of Sediment analysis and other two are in cgarge of Water Quality analysis.

(c) Observation Unit in the Basin Office

Four staffs in Far Western office, six staffs in Western office, two staffs in Central office and four staffs in eastern office will be sufficient in consideration of number of stations, accessibility to the station, and field schedule such as discharge measurement, inspection and data collection.

(d) Instrument Workshop at the Basin Office

The staffs in Far Western office, two staffs in Western office and four staffs in Eastern office will be sufficient in consideration of number of instruments and accessibility to the station. Central workshop Unit is in charge of instruments belong to Central Basin Office.

(e) Laboratory in Basin Office

Each two staffs in Far Western, Western and Eastern office will be sufficient. Central laboratory is in charge of analysis belongs to Central office.

(f) Basic Hydrological Station

Each two technical staffs will be sufficient to carry out routine hydrological observation and preliminary data processing at 10 basic stations

(g) Branch Office

Each two technical staffs will be sufficient to carry out field meteo-hydrological observation and data processing at 10 branch offices

(h) Synoptic Station

One staff at Jumula, Pokhara, Okhaldhunga and Taplejung, two technical staffs at other stations will be sufficient to carry out routine meteorological observation and data processing. Above four stations will be located in branch office or near basin office.

Number of the technical staffs proposed in the Long Term Programme is given in Table.

7.9 Training and Education

(1) General

The DHM must train staffs regularly and systematically to improve quality of staffs and observers.

So far, a lot of training programmes on the job and through fellowships abroad have been provided by the USAID, WMO, UNDP, UNESCO and supporting Projects. The DHM also has attended the seminar held by the WMO, SAARC and GDS. But the DHM did not have regular training by themselves. Recently, the DHM established the Training Unit and held training to the junior staffs for about three months.

In the Long Term Programme, systematic and intensive training should be planned to get reliable data aiming at the following main target points:

1) to understand fundamental knowledge about hydrology and meteorology
2) to master observation instrument and proper observation procedure
3) to master correct data processing procedure following the manual
4) to master technique about data check, and
5) to master the operation of computer

(2) Training on Observation System

Regular and systematic training are important for following staffs and training menu should be provided considering to trainees level and work responsibility:

1) Part-time observers

2) Field technicians

3) Staffs of sediment and Water Quality Laboratory

4) Mechanics and Electricians of Instrument Workshop

1) For Part-time Observers

It is not too much to say that data quality is mostly determined by their observation results.

Basically observation procedure and method is simple, but regular training for part-time observers is very important.

Mainly the training for observers should be carried out on the job training way when a field technician will visit site.

The technician have to will train observers with the observation Manual and instruct them to conduct proper observation.

Although it is difficult for observers to come to the office, basic training course for them is recommended to be held in DHM office in order to realize the importance of observation and to raise their motivation.

2) For Field Technicians

Training menu for them have to include observation method basic data processing, survey repair technique and so on.

The main training items for them are below:

(a) Observation method and procedure

(b) Inspection method and procedure

(c) Preliminary data processing and check

(d) Operation, calibration technique of instruments

(e) Minor repair technique of instruments

(f) Survey

(g) Basic knowledge of civil construction work

(h) Basic knowledge of instruments

(i) Basic knowledge of Hydrology and Meteorology

3) Staffs of Sediment and Water Quality Laboratory

General methods and procedure of sediment and water quality observation and, data processing, analysis, basic knowledge of sediment and water quality and so on are training menus for staffs of Laboratory.

It will be beneficial for chief of Laboratory to attend seminars on Sediment on Water Quality.

Foreign expert is necessary as a trainer, design of training programme associated with DHM Chemist.

4) Mechanics and Electronics of Instrument Workshop

Since there is no factory or workshop of instruments in Nepal, mechanics and electronics of instrument workshop have to master practical techniques as much as possible.

At present, it is difficult to carry out practical training for them by DHM because there is no specialist i DHM.

So, it may be an effective ways to train staffs in India or other neighboring countries and to send them to instrument manufacture for the training purpose.

Study on new technology of observation instruments is important, therefore it is beneficial for DHM to attend foreign seminar on this matter.

(3) Training Center at Central Office

For effective and regular training, Training Center is proposed to be established at the Central Office in the Long Term Programme and foreign experts are necessary as trainers, designer of training programmes, instructor of DHM trainers and so on.

7.10 Implementation Schedule

The Long Term Programme consists of three stages: the first stage (which is considered as the Immediate Programme) up to 1995, the second stage from 1996 to 2000 and the third stage from 2001 to 2005.

Plans to be proposed on observation system in each stage are summarized below.

(1) The First Stage (Immediate Programme)

The prime objective in this first stage is urgent improvement of existing hydro-meteorological system and following items are to be included:

(a) Reinforcement and Repair of existing ordinary raingauges (82 stations) with no extension of existing network (266 stations), Addition of 10 recording raingauges and Replacement of 4 ones.
(b) Minimum required repair of existing measuring equipments for water level observation and establishment of 10 basic hydrological stations.
(c) Minimum required repair of existing measuring equipments for discharge measurement and Addition of current meters.
(d) Completion of sediment observation network (20 stations) and Reinforcement/Addition of Sampling equipments.
(e) Reinforcement/Addition of equipments for sediment analysis
(f) Establishment of Calibration facility for current meter
(g) Reinforcement of workshop equipments at Central Office
(h) Training by foreign experts on overall observation system, calibration for current meter, sediment analysis and Training in Instrument Manufacturer for workshop staffs.

(2) The Second Stage

Aim of the second stage is initial extension of existing system such as expansion of observation network and introduction of new observation and following items are to be included:

(a) Establishment of 102 new ordinary raingauge stations, Addition of 15 recording raingauges and Replacement of 10 recording ones.

(b) Completion of 38 primary stations including 4 new stations and Repair/Reinforcement/Addition of measuring equipments for water level observation.

(c) Repair/Reinforcement/Addition of measuring equipments for discharge measurement and Addition of current meters for Primary Stations.

(d) Introduction of sampling of river bed materials and installation of sampling equipments.

(e) Introduction of Water Quality Observation and installation of test kits sensor and laboratory equipment for BOD and COD.

(f) Introduction of Graduation analysis and installation of laboratory equipments

(g) Introduction of workshop in Basin offices and installation of workshop equipments

(h) Training by foreign expert on overall observation system, calibration for current meter, sediment observation, water quality observation and Training in Instrument Manufacture for workshop staffs.

(3) The Third Stage

Aim of this final stage is completion of precipitation and water level minimum required observation network and following items to be included:

(a) Establishment of 102 new ordinary raingauges and Addition of 7 recording raingauges

(b) Completion of 62 secondary hydrological stations including 17 new stations and Repair/Reinforcement/Addition of measuring equipments for water level observation

(c) Repair/Reinforcement/Addition of measuring equipments for discharge measurement of Secondary Stations

(d) Completion of 11 Water quality observation network and Addition of field test kit, sensor and laboratory equipment for BOD/COD

(e) Introduction of telemetry system and establishment of 3 telemetry stations

(f) Training by foreign experts on overall observation and Training in Instrument Manufacture for workshop staffs.

The implementation schedule is shown in Fig. 7.5 proposed and observation equipments given in Table 7.14. The general idea of observation system is shown in Fig. 7.6.

7.11 Project Cost

Project cost related to observation system is estimated under the following conditions.

- The cost of the observation equipments is estimated by CIF at Kathmandu based on the price level in February, 1993.

- The exchange rates on February, 1993 are applied.

1.0 US Dollar = 46.4315 Nepali Rupees
= 121.05 Japanese Yen

- Prices of instruments and facilities are mainly referred from the Study of the Model System in the First Home work in November 1991.

- The cost for spare parts of each instrument is estimated 10% of total cost of instruments.

- Local currency is required for the labour cost, purchase of domestic materials and the transportation charge in the territory of Nepal.

The summary of project cost related to observation system is given in Table 7.15.

Following costs are not included in this table, however these costs are included in total project cost attached in Main Report.

- Annual price escalation for both foreign and local currency

- The contingency

- The general administrative expenses of the Government of Nepal and the engineering services for design and supervision to be tendered by a foreign consultant.

- The operation and maintenance cost

8. IMMEDIATE PROGRAMME

8.1 Purpose of Immediate Programme

The present observation and data management systems have not furnished the hydro-meteorological data with enough quality and quantity for evaluation of nationwide hydrological phenomena and characteristics. The first priority should be put on the quality of the data instead of the quantity in stepwise improvement programme of the systems.

The Immediate Programme, then, concentrates to improve quality of the hydro-meteorological data urgently by strengthening the existing hydro-meteorological observation and data management system without large physical expansion of the system.

This strengthening work includes

1) Restructuring of the DHM organization with introducing Basin and Branch Offices, and institutional rearrangement by employing 18 Subsystems,

2) improvement of observation and its maintenance activities by repairing existing observation/analysis equipment and facility, introducing basic stations and current meter calibration facility and manual preparation and staff training,

3) improvement of data processing and management activities by introducing computers and manuals with staff training

4) improvement of monitoring and evaluation works of all the activity.

8.2 Improvement Items Selected for Immediate Programme

The following items are selected as the reinforcement and improvement work items on observation system to be included in the Immediate Programme to achieve the targets to raise the quality of the hydrometeorological data.

(1) Observation

The Programme includes:

1) Repair and replacement of existing raingauge and addition of recording gauge.
2) Minimum required repair of primary and Establishment of basic hydrological stations.

3) Improvement and addition of discharge measurement instruments and Addition of current meters.

4) Repair and addition of sampling instruments and completion of sediment network.

5) Review and modification of manuals.

(2) Sediment and Water Quality Analysis

The Programme includes:

1) Repair and reinforcement of sediment analysis instruments.

2) Review and modification of manuals.

(3) Establishment, Inspection and Maintenance of Facility

The Programme includes:

1) Repair and reinforcement of existing workshop in the Central Office,

2) Establishment of calibration facility for current meter,

3) Review and modification of manuals.

(4) Data Quality Improvement and Training on Observation

The Programme includes:

1) Establishment of a training center in the Central Office with training programmes,

2) Training by foreign experts on general hydrometeorological observation and other special items.

3) Training in Instrument Manufacture for Workshop Staffs.

8.3 Proposed Plans of the Immediate Programme

8.3.1 Observation

(1) Rainfall Observation

Immediate programme concentrate to reinforce and repair existing precipitation observation system without expansion of the network. Precipitation network in this first stage consists of 266 existing stations including 38 recording stations, which are 14 existing, 14 model system and 10 newly proposed stations as shown in Table 8.1. Number of recording

raingauges are determined according to the Norm of the WMO, at least 10% of raingauges are to be equipped with recorder in the network.

Following items are to be proposed in the Immediate Programme:

(a) Repair and Replacement of existing ordinary raingauges:

Not only replacement of damaged gauges but also relocation/improvement of some gauging stations located at appropriate sites affected by surrounding corn field, trees, houses and so on should be conducted. As the results of field investigations, out of 42 visiting meteorological stations 9 stations are located at inappropriate sites.

(b) Replacement of 4 existing recording gauges:

4 recording raingauges at stations, No. 0219 No. 0303 No. 804 and No. 1319 which are in trouble condition, are to be replaced.

(c) Addition of 10 recording gauges:

10 recording stations listed in Table 8.1 (Station No. 0218, 0312,0416, 0725, 1002, 1103, 1107, 1212, 1301, 1421) are selected considering uniform distribution and characteristics of rainfall pattern.

(d) Preparation of Manuals and training:

Activities of part-time observes and field technicians greatly affect quality of data. Practical Manuals and effective training are essential to improve data quality.

Tipping bucket-type gauge which equips both data logger and chart drum recorder is to be installed in low land areas, in the mountainous and hilly areas located above about EL 2,000 m weighing-type gauge is to be installed. So, 1 weighing-type gauge at Station No. 218 and 13 tipping-bucket type gauges at other Stations are to be selected. Periodic check and maintenance is important for weighing-type gauge to operate in good condition.

(2) Water level observation

Proposed hydrometric observation network consists of three types of stations, i.e. basic, primary and secondary station. Total 110 stations which consist of 10 basic, 38 primary and 62 secondary stations are selected as minimum water level network. The network includes 21 new established stations.
Following items are to be planned in the Immediate Programme.

1) Minimum required Repair of existing measuring equipments and facilities.

1) Minimum required Repair of existing measuring equipment and facilities:

Repair and reinforcement of Primary and Secondary stations will be scheduled in the second and third Stage of the Long Term Programme respectively. In the first stage, minimum required repairs such as installation of single winches, replacement spare parts of damaged recorder, repair of cable and so on mainly for Primary stations.

2) Establishment of 10 basic hydrological stations.

Basic hydrological station is the key station located down stream of the main basin and distributed at the basic point for water resources development planning and river managing.

Following 10 stations are basic stations:

Station No.	River Basin / Station Name	Station No.	River Basin / Station Name
150	Mahakali / Pancheshwor	450	Gandaki / Naroyanghat
280	Karnali / Chisapani	589	Bagmati / Pandhera Dova
289.95	Babai / Chepang	598	Kamala / Chisapani
350	West Rapti / Bagasoti Gaon	695	Koshi / Chatara Kotsu
390	Tinau / Butwal	795	Kankai / Mainachuli

Following equipment and facilities should be completed at each basic station to carry out accurate and continuous observation.

(a) Staff gauge facility (3 sections)

(b) Water level recorder and facility

(c) Double drum winch cable way applied for bank operating system and propeller current meter

(d) Point integrated sampling equipment and turbidity meter for insitu sediment observation

(e) Office building

Present condition of each selected station is summarized in Table 8.2 and following proposals are made on basis former studies and model system operation.

Station No. 390 and No. 598 are proposed to be shifted to appropriate site and detail field investigation should be done for site selection.

(a) Staff gauge facility

Timely and frequent flood measurements by means of float and slope-area method will be conducted by using these staff gauges. At present, only station No. 150 provides 4 sections of staff gauge.

(b) Water level recorder with data logger and facility

Gauge wells at Station No. 150 and No. 280 are functioning well by means of clearing intake pipes and gauge well manually with a shovel and steel rods or a engine-driven potable pump.

Gauge wells at Station No. 450, No. 589, No. 695 and No. 795 should keep good condition to conduct continuous silt clearance.

Gauge well at Station No. 350 should repair to function against scouring river bed.

Since it is difficult to select the suitable site for a gauge well at Station No. 390 and No. 598 due to river condition, a pressure-type gauge is proposed due to its advantages of easy and cheap installation work and so on.

A gauge well at Station No. 289.95 suffers from serious scouring problem, so pressure-type gauge is also proposed.

Both existing and new recording gauge is recommended to equip data logger. Existing float-type recorder can equip data logger easily by attachment of encoder without interfering with actual function of the chart recorder, so it serve as an excellent back-up system. Pressure-type gauge is also recommended to equip built-in display for control of pressure sensor and data logger. Observers can check operational condition of data logger easily.

For clearing the gauge well which suffers from a lot of silt deposits, the pump can stain up deposited silt and force the water-sediment mixture out of the well easily.

(c) Double drum winch cable way applied for bank operating system and propeller current meter

At Station No. 150 and No. 280 double drum winch cable ways applied for bank operating system is working. This system has the advantages of safe operation and easy handling of a heavy weight during high flood.

A engine-driven winch available for heavier weight may be useful for a view of wide span and deep depth.

Width of the river bed is too wide to install cable way at Station No. 598, so adjacent bridge is to be used for measurements. At each station, propeller-type current meter is to be provided.

(d) Sediment Sampling by using point integrated sampler and insitu sediment observation

Point integrated Sampling and analysis is conducted at station No. 150 and No. 280. Point integrated sampling is recommended at each basic station because generally in wide and deep rivers more accurate data can be obtained. Sampling schedule, Sampling points and location and so on should be considered.

Turbidity is one of the indirect index to obtain the sediment concentration. Field measurement of turbidity is one of the effective sediment observation method because of omission of manpower and time for sampling, transporting and routine analyzing.

(e) Office building

Office buildings at Station No. 150, No. 280, No. 450, No, 589 and No. 795 were constructed. Continuous observation and maintenance by stationed staffs make date quality more reliable .

8.3.2 Sediment Observation

(1) Sediment Sampling

In the Immediate programme, sediment sampling network which consists of following 20 stations including 10 basic stations should be completed.

- Basic Stations (10)

	Station Name	Proposed method	
150	Mahakari	Point integration	(P)
280	Karnali	ditto	(P)
289.95	Babai	ditto	–
350	West Rapti	ditto	(D)
390	Tinau	ditto	–
450	Gandaki	ditto	(D)
589	Bagmati	ditto	(D)
598	Kamala	ditto	–
695	Koshi	ditto	(D)
795	Kankai	ditto	–

- Other Stations (10)

	Station Name	Proposed method	
240	Karnali	Point integration	(D)
270	Bheri	ditto	(D)
410	Kali Gandaki	ditto	(D)
439.7	Marsyangdi	ditto	(D)
445	Burhi Gandaki	ditto	(D)
447	Trisuli	ditto	(D)
600.1	Arun	ditto	(D)
670	Dudh Koshi	ditto	(D)
680	Sun Koshi	ditto	–
690	Tamur	ditto	(D)

Note : (P) existing point integrated Sampling Station
(D) existing depth integrated Sampling Station

Simple insitu measurement of suspended sediment by using turbidity meter is proposed to be introduced at 10 basic stations and Station No. 550.05.

Following instruments are to be provided to reinforce existing instruments.

(a) 8 point integrated samplers to be installed at basic stations

(b) 5 depth integrated samplers to be installed at other sampling stations

(c) 11 turbidity meters at basic stations and No. 550.05 are to be installed.

(2) Sediment Analysis

To strengthen existing sediment laboratory following.

(a) 5 electric ovens and big and small scall electric balances re to be provided.

(b) For proper and efficient sediment observation, manual and training is essential

8.3.3 Establishment, Inspection and Maintenance of Facilities

In the Immediate programme, establishment, Inspection and Maintenance system are to be improved as following manners.

(1) Improvement of establishment system

The newly proposed evaluation office in the Central office will take in charge of design matters such as network design, structural design, selection of instruments and soon. The Basin office will supervise and be responsible for the civil construction work.

(2) Improvement of Inspection and Maintenance system in the Basin Office

Following points are to be reviewed to improve the system:

(a) Inspection and maintenance Manuals for part-time observers, field technicians mechanical and electric technicians to be provided

(b) Effective inspection system to be provided, which consists of:

- Daily Inspection by part-time observers
- Periodic (three monthly) inspection by field technicians
- Periodic (six monthly) instrument inspection by mechanical technicians
- Overall Annual inspection by Hydrologist/Meteorologist
- Occasional inspection

(c) Effective inspection schedule to be included.

(d) Appropriate Organization and Staffing for effective inspection to be provided.

(e) Effective and practical training for part-time observers, field technicians, mechanical and electric technicians to be conducted.

(3) Improvement of Inspection and Maintenance System in Central Office

Central office should support the Basin office as to function well and the Basin office should inform and report field activities continuously to Central office.

Staffs of Central Laboratory and workshop should give staffs of Basin Laboratory and workshop proper guidance and advices.

1) Instrument Workshop in Central office

Instrument workshop should handle following kinds of repair and calibration.

(a) Mechanical instrument repair

(b) Electrical and electronic instrument repair

(c) Calibration of observation instruments

The workshop will function well under following conditions:

(a) Sufficient spare parts and spare instruments should be stocked because repair of instruments always appear urgent and spare parts are always needed.

(b) Sufficient repair machines and tools, calibration equipments should be provided.

(c) Well-trained mechanics and electricians and theorical/practical training for them are required.

(d) Well-functional organization should be established and effective management should be conducted.

Based on above view points following improvement is proposed:

(a) Lack of spare parts and spare instruments is one of the major reason why existing workshop malfunctions, so sufficient spare parts and spare instruments should be provided.

(b) Major mechanical machines such as Large/Small Bench Lathe Machines, Large/Small Bend drill Machine, Griding machine and so on are installed, however electrical and electronic equipments are insufficient at present instrument work shop.

Following machines/equipments are to be provided:

- Small arc-welding machine
- Power transformer
- Set of electrical hand-tools
- Set of electrical measuring instruments such as Multimeter Portable transistor and diode tester etc

(c) Generally no special equipments is necessary to calibrate recording raingauge and water level gauge. Only simple devices for checking the value of rainfall and water level recorder will be useful. Following equipments are to be provided for calibration except Caribration facility for current meter.

- Time balance for adjustment of drum clock
- Device of checking the value of Tipping bucket type raingauge and water level gauge
- Calibration weight for weighing type raingauge

(d) The electrical engineer is required to maintain electrical/electronic instruments such as data logger, both mechanical and electrical engineer should take practical training and are recommended to master repair/maintenance technics at Instrument Manufacture,

(e) Technicians of the Central office should contact the Basin office and exchange information on condition of instruments. If the Basin workshop can not repair a damaged instrument, the central workshop will try to repair and if they can not repair they will send it to Manufacture.

2) Calibration facility for current meter

Regular calibration of current meter is essential for reliable data.

The operational activities of the calibration for current meter are fairly routine and repetitive. Staff s in charge of Calibration laboratory should be trained technics by a professional engineer until they can operate and manage it by themselves.

8.3.4 Training and Education

Training system which consists of regular training course and special training course to train the DHM staffs in both observation and data management are proposed and the training center will be constructed to perform effective and smooth training programme. Field training and training for staffs who belong to Instrument Workshop and Laboratory are described below:

(1) Field training

(a) Field technician

Field technicians have to carry out various field activities such as discharge measurement, inspection of the station, minor repair and adjustment of instruments, survey and civil construction works and so on. On the job training is effective to master above activities and basic knowledge will help easy and fast understanding for them. General items of field training are give in Table 8.3.

(b) Part-time Observer

Although observation works are always simple and routine, it is difficult for most observers to continue perfect observation. Periodic instruction and training by field technicians are important. Brief training course for observers, is recommended to be held at the DHM office every year.

(2) Training for Workshop Staffs

Both mechanical and electrical repair/maintenance of meteorological and hydrological instruments should be carried out instrument workshop.

On the job training is effective way to master the technics of repair and maintenance work. Although it is difficult to take sufficient training of both mechanical and electrical repair and maintenance in Nepal.

So, practical training at instrument manufacture or in Indian or neighbour country's work shop are beneficial for them.

Training of calibration for current meter by using proposed calibration tank will be done by foreign experts.

(3) Training for Laboratory Staffs

In the immediate Programme, water quality observation is not included. Training for Laboratory staffs is to concentrate sediment observation since sediment network in whole country is to be completed in this stage.

Quality of data depends on both field sampling and laboratory analysis therefore laboratory staffs should control and manage both of jobs.

Training curriculums will include basic knowledge and filed and laboratory practice and a foreign expect is recommended to train.

8.3.5 Calibration Facility for Current Meter

(1) General Requirements

Full fledged standard current meter calibration facility are required to be calibrated up to the maximum speed 10 m/sec.

Technical requirement of the calibration facility should meet "Calibration of current meters in straight open tank" of the International Organization for Standardization (ISO, 1976).

(2) Technical Specification

1) Design conditions of the facilities

(a) Design conditions of the tank and the carriage are to be as follows:

a) Tank dimensions

- Width : 2.0 m
- Length : 160 m
- Tank depth : 2.3 m
- Water depth : 2.0 m

b) Electric power supply : AC 208/120 V (+/-10%), 60 Hz, 3/1 phase

c) Ambient temperature : 5 to 40 degree in centigrade

d) Relative humidity : Less than 85%

(b) The towing carriage, consisting of a body structure of pipe girder, a driving and brake equipment, a control equipment, an test frame and auxiliary fittings, runs lengthwise over the test tank, at the maximum speed of 10 m/sec., towing a current meter.

(c) The railway consists of two rails fitted along both sides of the tank. The carriage has ordinary 4 drive wheels on the railway, plus 4 side-wheels for guiding purpose.

(d) In order to assure a wide range of travel speed, the drive equipment includes both high-speed system and low-speed system. that is, when running at speed slower than 1.0 m/sec., the carriage is driven with one 0.4 kW motor. When running at speeds from 1.0 m/sec. up to 10 m/sec., the carriage is driven with two 2.2 kW motors.

2) Operation of the Calibration Facility

(a) A current meter is to be fitted on the carriage before starting the carriage.

(b) The operator is to give the following commands to the carriage remotely, with a wireless controller.

- carriage speed
- carriage start
- carriage emergency stop

Such controls as carriage acceleration/deceleration, normal-stop, and turn-round are done automatically.

(c) A middle part of the tank is to be a test section defined with one pair of proximity switches.

Length of the test section (L) is to be 100 m.

(d) While running the test section, the carriage travel time (T) and the number of revolutions of the current meter (N) are measured automatically, with a timer/counter.

Going out of the test section, the carriage automatically decelerates to stop, and returns to the home-position for a next travel.

(d) At home position, the operator reads these data (T and N) from the timer/counter, calculating the following calibration values.

Current speed : $v = L/T$

Current meter RPS : $n = N/T$

(3) Design of the Calibration tank

1) Length

The total length of a calibration tank should be considered as comprising accelerating, stabilizing, measuring and breaking sections.

The duration of the test should be at least 10 seconds at maximum speed, so the maximum speed is 10 m/sec. then the measuring section would be 100 m long, which is 10 times of maximum speed according to ISO..

Accelerating and breaking section of the tank is respectively 25 m based on capacity of the towing carriage and 10 m of parking section. Therefore total length of the tank is below:

$$L = 100 + 25 + 25 + 10 = 160 \text{ m}$$

2) Depth and width

The wave crest produced by the current meter may cause a reduction of the relative velocity depending upon the towing speed. This disturbance, known as the Epper effect, may cause an error in calibration in the velocity range from 0.5 V_{cr} to 1.5 V_{cr} ($V_{cr} = \sqrt{gd}$ where g is the acceleration due to gravity and d is depth of water). So the depth and width of the tank should be chosen to suit the maximum velocity limits of the instruments to be calibrated.

Suppose to 2.0 m wide and 2.0 m depth of the tank, the Epper effect is greatest at a speed of about 4.4 m ($\sqrt{9.81 \times 2.0}$) and detectable at velocities between 2.2 m/s and 6.6 m/s.

8.3.6 Implementation Schedule

The immediate programme is the first stage of the Long-term programme up to 1995. This stage aims to improve the existing hydro-meteorological observation system urgently without big expansion. The implementation schedule is given in Fig. 8.1

Detail design on civil construction and equipments will be carried out in 1993 and construction and installation of equipments will start from 1994 and end in 1995.

All equipments should be installed properly according to the requirement and adjusted or if necessary recalibrated in the field. Both Appropriate Operation/Maintenance Manuals and field guidance for the DHM staffs are provided.

8.3.7 Project Cost

Project cost of the Immediate programme is estimated under the same conditions as those in the Long term programme.

Project cost of the Immediate programme is given in Table 8.3 and summarized below:

Item	FC x 1000 NRp	LC x 1000 NRp
(1) Rainfall observation		
(a) Repair/Replacement of Ordinary gauge	0	1,320 (82)
(b) Replacement of Recording gauges	1,662 (4)	0
(c) Addition of Recording gauges	4,900 (10)	1,000 (10)
(d) Spare Parts/Consumables	656	0
(2) Water level Observation/Discharge Measurement		
1) Basic Station		
(a) Addition of staff gauge	0	360 (20)
(b) Maintenance/Repair of gauge well and Addition/improvement* of float-type gauge	1,108 (4) 380 (4)	110 (5) -
(c) Installation of pressure type gauge	1,524 (3)	363 (3)
(d) Installation/improvement* of double winch cable way	10,576 (8)	5,970 (5) 1,120* (2)
(e) Office building	0	1,850 (5)
(f) Current meter	7,614 (9)	0
(g) Survey instrument	2,250 (5)	0
(h) Spare parts/consumables	2,108	0
2) Primary Station		
(a) Repair/Reinforcement of single winch cable way	0	3,094 (14)
(b) Current meter	10,456 (16)	0
(3) Sediment Observation		
(a) Addition of sampling equipments (point and depth integrated sampler and turbidity meter)	7,457	0
(b) Reinforcement of Laboratory equipments	1,220	0
(c) Spare parts	746	0
(4) Work Shop		
(a) Addition of repair/calibration equipments	1,108	0
(b) Calibration facilities for current meter	21,073	6,663
(5) Data Processing (Data logger system such as software reader and memory card)	4,954	0
(6) Engineering service on design and installation of instrument	8,043	0
(7) Training (Invitation of foreign experts and Training in instrument manufacture)	29,044	0

Note: Price escalation is not included
( ) Number of equipments
* : Addition of data logger

Reference

(1) ISO748, 1973 : Liquid flow measurement in open channels by velocity area method

(2) ISO 3435, 1976 : Calibration of current meters in Straight open tank

(3) WMO, 1980 : Manual on Stream gauging Volume I Field work

(4) WMO, 1981 : Guide to Hydrological Practices Volume I Data Acquisition and Processing Fourth edition

(5) WMO, 1988 : Technical Regulations Volume III Hydrology 1988 edition, ANNEX 1 Hydrological Instruments and Methods of observation

(6) WMO, 1989 : Manual on Operational Methods for the measurement of sediment transport, Long Yuquin

(7) WMO, 1981 : Measurement of River Sediment

(8) WMO, : Manual on Water-Quality Monitoring

(9) WMO, 1986 : Level and Discharge Measurements under difficult conditions, O.A. Tilrem

(10) United States department of the interior bureau of reclamation, 1984
: 2nd edition, Water Measurement Manual

(11) WMO, 1986 : Compendium of lecture Notes on Meteorological Instruments for training class III and Class IV Meteorological Personel Volume I

(12) WMO, : Guideline for the education and training of personal in Meteorology and operational Hydrology 2nd edition

(13) Ray K. Linsley, Jr. Max A. Kohler, Joseph L. H. Paulhus, Hydrology for Engineers

(14) UNDP & WMO, Agrometeorology and Instrument Maintenance NEP/78/019 Project Findings and Recommendations, 1988

(15) Water Quality Monitoring of Kathmandu City Water Supply Final Report 1989. Family planing Association of Nepal/Disvi Health Education & Service Project

(16) Report of the First Consultative Meeting of the Regional Working Group on Mountain Hydrology, UNESCO/IHP and KIMOD October 1990

(17) Snow and Glacier Hydrology Project, Year Book for 1987-1989 First, issue July 1990.

(18) Report on Water Quality Study Programmes (July 1991)

(19) Environment & Public Health Organization Divi International Cooperation

(20) Proposal to set up a Water Quality Laboratory, Dr. Bhukti Shrestha, A. Hoftmann, B. K. Vaidya (GDS & DHM), July 1972

(21) Report on How to set up a Water Quality Laboratory in the Department of Hydrology & Meteorology, Rudigar H, Bhukti Shrestha (GDS & DHM) December, 1990

(22) German Volunter Report

(23) Compilation of Surface Water Records of Nepal through December 31, 1965

(24) Climatological Records of Nepal

(25) Nepal Meteorological Service Manual of Observation, WMO Advisers June 1978

(26) Hydrological Network and Hydrometric Problems in Nepal, Kiran Shankar (DHM), December 1989

(27) Nepal in Map, S. H. Shrestha, 1988

(28) Hydrological Observations with illustrations, Central Board of Irrigation and power, India

TABLES

Table 2.1 RIVER BASIN AREA

Name of River Basin		Basin Area (sq.km)	Percentage of Basin Area within Nepal
I.	MAHAKALI RIVER	5,317	34%
II.	SOUTHERN BORDER RIVER GROUP NO. 1	3,811	100%
III.	KARNALI RIVER	(43,227)	
	1. HUMLA KARNALI	5,527	65%
	2. MUGU KARNALI	6,155	100%
	3. SINJATILA	3,252	100%
	4. SETI WEST	7,103	100%
	5. BHERI	13,867	100%
	6. KARNALI MAIN (OTHERS)	7,323	100%
IV.	BABAI RIVER	3,252	100%
V.	WOUTHERN BORDER RIVER GROUP NO. 2	948	100%
VI.	RAPTI (WEST) RIVER	6,215	100%
VII.	SOUTHERN BORDER RIVER GROUP NO. 3	4,849	100%
VIII.	NARAYANI/GANDAKI RIVER	(31,726)	
	1. TRISULI	3,622	57%
	2. BUDHI	3,621	73%
	3. MARSHANGDI	4,819	100%
	4. SETI (GANDAKI)	2,843	100%
	5. KALI GANDAKI	11,573	100%
	6. RAPTI (GANDAKI)	2,993	100%
	7. NARAYANI/GANDAKI MAIN (OTHERS)	2,255	100%
IX.	SOUTHERN BORDER RIVER GROUP NO. 4	3,502	100%
X	BAGMATI RIVER	3,681	100%
XI.	SOUTHERN BORDER RIVER GROUP NO. 5	3,013	100%
XII.	KAMALA RIVER SYSTEM	1,786	100%
XIII.	SOUTHERN BORDER RIVER GROUP NO. 6	1,896	100%
SVI.	SUN KOSHI.SAPTA KOSHI RIVER	(27,863)	
	1. BHOTE KOSHI	240	10%
	2. TAMA KOSHI	2,714	76%
	3. DUDH KOSHI	4,030	100%
	4. ARUN	5,248	15%
	5. TAMAR/TAMUR	6,125	100%
	6. SUN KOSHI MAIN (OTHERS)	9,506	100%
XV.	SOUTHERN BORDER RIVER GROUP NO. 7	3,462	100%
XVI	KANKAI RIVER	1,317	100%
SVII.	SOUTHERN BORDER RIVER GROUP NO. 8	1,316	100%
	TOTAL	147,181	

Table 4.1 LIST OF WATER LEVEL AND RAINFALL STATIONS
OF NEPAL-INDIA FLOOD FORECASTING PROJECT

No.	Station	River	Existing Equipment	Equipment to be provided
I.	Water Level and Rainfall Gauge			
(1)	Karnali River Basin			
1.	Benighat	Karnali	G, D	SG, OR, SRG, W
2.	Bangga	Seti	SG, D, OR	SRG, W
3.	Jamu	Bheri	SG, D, OR	SRG, W
4.	Raskot	Karnali	OR	SG, OR, SRG, W
(2)	West Rapti			
5.	Jalkundi	Jalkundi	SG, D	OR, SRG, W
6.	Bhalubang	Bhalubang	SG, D	OR, SRG, W
(3)	Gandaki			
7.	Narayan Ghat	Narayani	SG, D	OR, SRG, W
8.	Ansing	Kali Gandaki	-	SG, D, OR, SRG, W
(4)	Bagmati			
9.	Pandhera Dobhan	Bagmati	SG, D	OR, SRG, W
10.	Hariharpur Gharhi	Bagmati	OR	SG, D, SRG, W
11.	Batra	Bagmati	-	SG, D, OR, SRG, W
12.	Patherkot	Bagmati	OR	SG, D, SRG, W
(5)	Kamala			
13.	Chisapani	Kamala	OR	SG, D, SRG, W
(6)	Kosi			
14.	Pachuwar Ghat	Sun Kosi	SG, D	OR, SRG, W
15.	Toksel Ghar	Sun Kosi	G	SG, D, OR, SRG, W
16.	Rabuwa Bazar	Dudh Kosi	SG, D	OR, SRG, W
17.	Turki Ghat	Arun	SG, D	OR, SRG, W
18.	Majhitar or Angba Ghat	Tamur	G, D	SG, OR, SRG, W SG, D, OR, SRG, W
(6)	Others			
19.	Pipra	Parman	-	SG, D, OR, SRG, W
20.	Mainachuli	Kankai	SG, D	OR, SRG, W
II.	Rainfall Gauge			
(1)	West rapti			
1.	Kusum		OR	SRG, W
2.	Bhairahawa		OR, W	SRG
(2)	Gandaki			
3.	Pokara		OR, W	SRG
4.	Simra		OR, W	SRG
5.	Belwa-Girwari		OR	SRG, W
6.	Musikot		OR	SRG, W
7.	Gorkha		OR	SRG, W
8.	Nuwakot		OR	SRG, W
9.	Beni		OR	SRG, W
10.	Arughat Bazar		OR	SRG, W
(3)	Kosi			
11.	Okhaldhunga		OR, W	SRG
12.	Taplejung		OR, W	SRG
13.	Dhankuta		OR, W	SRG
14.	Sidhuli Garhi		OR	SRG, W
15.	Lhumthung		OR	SRG, W
16.	Udaipur Garhi		OR	SRG, W
17.	Chaurikharka		OR	SRG, W
18.	Jiri		OR	SRG, W
19.	Num		OR	SRG, W
20.	Kathmandu		OR, SRG, W	-
21.	Ramoli-Bairia		OR	SRG, W
22.	Nijgarh		OR	SRG, W
23.	Barahakshetra		-	OR, SRG, W
(4)	Others			
24.	Harancha		OR	SRG, W
25.	Ilam		OR	SRG,W

Note : (1) D : Discharge Station, G : Staff Gauge, OR : Ordinary Rain Gauge,
SG : Automatic Water Level Recorder, SRG : Self Recording Rain Gauge
W : Wireless Set
(2) Locations of station from No. 10 to 12 and 19 of Item I. are tentative.

Table 5.1 GENERAL OBSERVATION ITEMS OF METEOROLOGICAL STATION

Observation Item	Aero/Synoptic Station	Agrometeo-rological Station	Climatology Station	Precipitation Station
(1) SKY Condition	○			
(2) Visibility	○			
(3) Atmospheric	○			
(4) Min./Max. Temperature	○	○	○	
(5) Relative Humidity	○	○	○	
(6) Precipitation	○	○	○	○
(7) Wind Velocity Wind Direction	○	○		
(8) Sunshine Duration Solar Radiation	○	○		
(9) Evaporation		○		
(10) Soil/Grass Min. Temperature		○		
Number of Station	14	24	65	149

Table 5.2 LIST OF METEOROLOGICAL STATIONS (1 / 5)

NO.	INDEX NO.	STATION'S NAME	TYPE OF STATION	REG.	LATI-TUDE		LONGI-TUDE		ELV. (m)	ACC.	ESTABLISHED DATE
1	101	KAKERPAKHA	PRECIPITATION	FW	29	39	80	30	842	HH	05/01
2	102	BAITADI	PRECIPITATION	FW	29	33	80	25	1,635	HH	02/01
3	103	PATAN (WEST)	CLIMATOLOGY	FW	29	28	80	32	1,266	HH	05/01
4	104	DANDELDHURA	SYNOPTIC	FW	29	18	80	35	1,865	HH	05/01
5	105	MAHENDRA NAGAR	AGROMETEOLOGY	FW	29	2	80	13	176	HH	02/01
6	106	BELAURI SANTIPUR	PRECIPITATION	FW	28	41	80	21	159	MD	02/01
7	107	DARCHULA	CLIMATOLOGY	FW	29	51	80	34	1,097	MD	02/01
8	108	SATBANJH	PRECIPITATION	FW	29	32	80	28	2,370	MD	06/01
9	201	PIPALKOT	PRECIPITATION	FW	29	37	80	52	1,456	MD	08/01
10	202	CHAINPUR (WEST)	CLIMATOLOGY	FW	29	33	81	13	1,304	MD	08/01
11	203	SILGADHI DOTI	CLIMATOLOGY	FW	29	16	80	59	1,360	HD	06/01
12	204	BAJURA	PRECIPITATION	FW	29	23	81	19	1,400	MD	01/01
13	205	KATAI	PRECIPITATION	FW	29	0	81	8	1,388	MD	12/01
14	206	ASARA GHAT	PRECIPITATION	FW	28	57	81	27	650	MD	03/01
15	207	TIKAPUR	CLIMATOLOGY	FW	28	30	80	57	140	HH	03/01
16	208	SANDEPANI	PRECIPITATION	FW	28	45	80	55	195	MD	12/01
17	209	DHANGADHI	CLIMATOLOGY	FW	28	41	80	36	170	HH	06/01
18	210	BANGGA CAMP	CLIMATOLOGY	FW	28	58	81	7	340		03/01
19	211	KHAPTAD	PRECIPITATION	FW	29	23	81	12	3,430	MD	04/01
20	212	SITAPUR	PRECIPITATION	FW	28	34	80	49	152	MD	02/01
21	214	KOLA GAUN	PRECIPITATION	FW	29	7	80	41	1,304	MD	02/01
22	215	GODAVARI (WEST)	CLIMATOLOGY	FW	28	52	80	38	288	HH	06/01
23	217	MANGALSEN	PRECIPITATION	FW	29	9	81	17	1,345	MD	01/01
24	218	DIPAYAL (DOTI)	SYNOPTIC	FW	29	15	80	57	617	HH	12/01
25	219	DHANGADHI	SYNOPTIC	FW	28	41	80	36	170		06/01
26	301	MUGU	PRECIPITATION	MW	29	45	82	33	3,803	MD	06/01
27	302	THIBRU	PRECIPITATION	MW	29	19	81	46	1,006	MD	12/01
28	303	JUMLA	SYNOPTIC	MW	29	17	82	10	2,300	1D	12/01
29	304	GUTHI CHAUR	PRECIPITATION	MW	29	17	82	19	3,080	MD	01/01
30	305	SHERI GHAT	PRECIPITATION	MW	29	8	81	36	1,210	MD	02/01
31	306	GAM SHREE NAGAR	PRECIPITATION	MW	29	33	82	9	2,133	MD	10/01
32	307	RARA	CLIMATOLOGY	MW	29	33	82	7	3,048	MD	10/01
33	308	NAGMA	PRECIPITATION	MW	29	12	81	54	1,905	MD	10/01
34	309	BIJAYAPUR (RASKOT)	PRECIPITATION	MW	29	14	81	38	1,814	MD	12/01
35	310	DIPAL GAUN	CLIMATOLOGY	MW	29	16	82	13	2,310	MD	06/01
36	311	SIMIKOT	CLIMATOLOGY	MW	29	58	81	50	2,800	MD	05/01
37	312	DUNAI	CLIMATOLOGY	MW	28	56	82	55	2,058	MD	06/01
38	313	DARMA	PRECIPITATION	MW	29	44	82	6	1,950	MD	09/01
39	401	PUSMA CAMP	CLIMATOLOGY	MW	28	53	81	15	950	MD	03/01
40	402	DAILEKH	CLIMATOLOGY	MW	28	51	81	43	1,402	MD	01/01
41	403	JAMU (TIKUWA KUNA)	PRECIPITATION	MW	28	47	81	20	260	MD	05/01
42	404	JAJARKOT	PRECIPITATION	MW	28	42	82	12	1,231	MD	12/01
43	405	CHISAPANI (KARNALI)	CLIMATOLOGY	MW	28	39	81	16	225	HH	01/01
44	406	SURKHET (BIRENDRA NAGAR)	SYNOPTIC	MW	28	36	81	37	720	HH	01/01
45	407	KUSUM	PRECIPITATION	MW	28	1	82	7	235	HH	11/01
46	408	GULARIYA	PRECIPITATION	MW	28	10	81	21	215	MD	01/01
47	409	KHAJURA (NEPALGANJ)	AGROMETEOLOGY	MW	28	6	81	34	190	HH	01/01
48	410	BALE BUDHA	PRECIPITATION	MW	28	47	81	35	610	MD	05/01
49	411	RAJAPUR	PRECIPITATION	MW	28	26	81	6	129	HH	02/01
50	412	NAUBASTA	PRECIPITATION	MW	28	16	81	43	135	MD	02/01

NOTE : ACC.(ACCESSBILITY)
HH : WITHIN HALF(0.5) HOUR WORKING DISTANCE
1D : WITHIN ONE(1) DAY HOUR WORKING DISTANCE
MD : MORE THAN ONE DAYS WORKING DISTANCE

Table 5.2 LIST OF METEOROLOGICAL STATIONS (2 / 5)

NO.	INDEX NO.	STATION'S NAME	TYPE OF STATION	REG.	LATI-TUDE		LONGI-TUDE		ELV. (m)	ACC.	ESTABLISHED DATE
51	413	SHYANO SHREE	PRECIPITATION	MW	28	27	81	35	302	MD	02/01
52	414	BAIJAPUR	PRECIPITATION	MW	28	3	81	54	226	MD	02/01
53	415	BARGADAHA	PRECIPITATION	MW	28	26	81	21	200	MD	11/01
54	416	NEPALGUNJ (REG.OFF.)	CLIMATOLOGY	MW	28	4	81	37	144	HH	02/01
55	417	RANI JARUWA NURSERY	CLIMATOLOGY	MW	28	23	81	21	200	MD	12/01
56	418	MAINA GAUN (D.BAS)	PRECIPITATION	MW	28	59	82	17	2,000	MD	05/01
57	419	SIKTA	AGROMETEOLOGY	MW	28	2	81	47	195	HH	05/01
58	501	RUKUMKOT	PRECIPITATION	MW	28	36	82	38	1,560	MD	07/01
59	502	SHERA GAUN	PRECIPITATION	MW	28	35	82	49	2,150	MD	07/01
60	504	LIBANG GAUN	PRECIPITATION	MW	28	18	82	38	1,270	HH	07/01
61	505	BIJUWAR TAR	PRECIPITATION	MW	28	6	82	52	823	MD	08/01
62	507	NAYABASTI (DANG)	PRECIPITATION	MW	28	13	82	7	698	HH	12/01
63	508	TULSIPUR	CLIMATOLOGY	MW	28	8	82	18	725	HH	12/01
64	509	GHORAHI (MASINA)	PRECIPITATION	MW	28	3	82	30	725	HH	12/01
65	510	LOILABAS	PRECIPITATION	MW	27	42	82	32	320	HH	02/01
66	511	SALYAN BAZAR	CLIMATOLOGY	MW	28	23	82	10	1,457	HH	11/01
67	512	LUWAMJULA BAZAR	PRECIPITATION	MW	28	18	82	17	885	HH	11/01
68	513	CHAUR JHARI TAR	CLIMATOLOGY	MW	28	32	82	1	910	1D	06/01
69	514	MUSIKOT (RUKUMKOT)	CLIMATOLOGY	MW	28	38	82	29	2,100	MD	07/01
70	515	GHORAI	SYNOPTIC	MW	28	3	82	30	725		07/01
71	601	JOMSOM	CLIMATOLOGY	W	28	47	83	43	2,744	1D	07/01
72	604	THAKMARPHA	AGROMETEOLOGY	W	28	45	83	42	2,566	1D	12/01
73	605	BAGLUNG	CLIMATOLOGY	W	28	16	83	36	984	1D	05/01
74	606	TATOPANI	PRECIPITATION	W	28	29	83	39	1,243	MD	05/01
75	607	LETE	PRECIPITATION	W	28	38	83	36	2,384	MD	05/01
76	608	RANIPAUWA (M.NATH)	PRECIPITATION	W	28	49	83	53	3,609	MD	05/01
77	609	BENI BAZAR	CLIMATOLOGY	W	28	21	83	34	835	MD	02/01
78	610	GHAMI (MUSTANG)	PRECIPITATION	W	29	3	83	53	3,465	MD	11/01
79	612	MUSTANG (LOMANGTANG)	CLIMATOLOGY	W	29	11	83	58	3,705	MD	09/01
80	613	KARKI NETA	PRECIPITATION	W	28	11	83	45	1,720	MD	02/01
81	614	KUSHMA	CLIMATOLOGY	W	28	13	83	42	891	MD	05/01
82	615	BOBANG	PRECIPITATION	W	28	24	83	6	2,273	MD	12/01
83	616	GURJA KHANI	PRECIPITATION	W	28	36	83	13	2,530	MD	12/01
84	619	GHORAPANI	PRECIPITATION	W	28	24	83	44	2,742	MD	03/01
85	620	TRIBENI	PRECIPITATION	W	28	2	83	39		MD	02/01
86	621	DARBANG	PRECIPITATION	W	28	23	83	24		MD	02/01
87	622	RANGKHANI	PRECIPITATION	W	28	9	83	34		MD	01/01
88	701	RIDI BAZAR	PRECIPITATION	W	27	57	83	26	442	HH	07/01
89	702	TANSEN	CLIMATOLOGY	W	27	52	83	32	1,067	HH	07/01
90	703	BUTWAL	CLIMATOLOGY	W	27	42	83	28	205	HH	07/01
91	704	BELUWA (GIRWARI)	PRECIPITATION	W	27	41	84	3	150	HD	02/01
92	705	BHAIRHAWA AIRPORT	AERONAUTICAL	W	27	31	83	26	109	HH	09/01
93	706	DUMKAULI	AGROMETEOLOGY	W	27	41	84	13	154	HH	10/01
94	707	BHAIRHAWA (AGRIC)	AGROMETEOLOGY	W	27	32	83	28	120	HH	01/01
95	708	PARASI	PRECIPITATION	W	27	32	83	40	125	HH	05/01
96	710	DUMKIBAS	PRECIPITATION	W	27	35	83	52	164	HH	05/01
97	715	KHANCHIKOT	CLIMATOLOGY	W	27	56	83	9	1,760	HH	11/01
98	716	TAULIHAWA	CLIMATOLOGY	W	27	33	83	4	94	HH	11/01
99	721	PATTHARKOT (WEST)	PRECIPITATION	W	27	46	83	3	200	HH	03/01
100	722	MUSIKOT	PRECIPITATION	W	28	10	83	16	1,280	HH	06/01

NOTE : ACC.(ACCESSBILITY)
HH : WITHIN HALF(0.5) HOUR WORKING DISTANCE
1D : WITHIN ONE(1) DAY HOUR WORKING DISTANCE
MD : MORE THAN ONE DAYS WORKING DISTANCE

MIN 72
MAX 4,091

Table 5.2 LIST OF METEOROLOGICAL STATIONS (3 / 5)

NO.	INDEX NO.	STATION'S NAME	TYPE OF STATION	REG.	LATI-TUDE		LONGI-TUDE		ELV. (m)	ACC.	ESTABLISHED DATE
101	723	BHAGWANPUR	PRECIPITATION	W	27	41	82	48	80	MD	01/01
102	725	TAMGHAS	CLIMATOLOGY	W	28	4	83	15	1,530	HH	11/01
103	726	GARAKOT	PRECIPITATION	W	27	52	83	48	500	MD	11/01
104	727	LUMBINI	PRECIPITATION	W	27	28	83	17	95	HH	10/01
105	728	SIMARI	CLIMATOLOGY	W	27	32	83	45	154	MD	04/01
106	801	JAGAT (SETIBAS)	PRECIPITATION	W	28	20	84	54	1,334	MD	07/01
107	802	KHUDI BAZAR	CLIMATOLOGY	W	28	17	84	22	823	MD	07/01
108	804	POKHARA AIRPORT	AERONAUTICAL	W	28	13	84	0	827	HH	10/01
109	805	SYANGJA	CLIMATOLOGY	W	28	6	83	53	868	HH	11/01
110	806	LARKE SAMDO	PRECIPITATION	W	28	40	84	37	3,650	MD	06/01
111	807	KUNCHHA	PRECIPITATION	W	28	8	84	21	855	MD	06/01
112	808	BANDIPUR	PRECIPITATION	W	27	56	84	25	965	HH	06/01
113	809	GORKHA	AGROMETEOLOGY	W	28	0	84	37	1,097	HH	06/01
114	810	CHAPKOT	CLIMATOLOGY	W	27	53	83	49	460	MD	02/01
115	811	MALEPATAN (POKHARA)	AGROMETEOLOGY	W	28	13	83	57	856	HH	04/01
116	813	BHADAURE DEURALI	PRECIPITATION	W	28	16	83	49	1,600	MD	05/01
117	814	LUMLE	AGROMETEOLOGY	W	28	18	83	48	1,740	HD	11/01
118	815	KHAIRINI TAR	AGROMETEOLOGY	W	28	2	84	6	500	HH	03/01
119	816	CHAME	CLIMATOLOGY	W	28	33	84	14	2,680	MD	07/01
120	817	DAMAULI	PRECIPITATION	W	27	58	84	17	358	HH	01/01
121	818	LAMACHAUR	PRECIPITATION	W	28	16	83	58	1,070	HH	01/01
122	820	MANANG BHOT	PRECIPITATION	W	28	40	84	1	3,420	MD	06/01
123	821	GHANDRUK	PRECIPITATION	W	28	23	83	48	1,960	MD	05/01
124	823	GHAREDHUNGA	PRECIPITATION	W	28	12	84	37	1,120	MD	07/01
125	824	SIKLESH	PRECIPITATION	W	28	22	84	6	1,820	MD	06/01
126	826	WALLING	PRECIPITATION	W	27	59	83	46	750		11/01
127	827	RUMJAKOT	PRECIPITATION	W	27	52	84	8	660		05/01
128	902	RAMPUR	AGROMETEOLOGY	C	27	37	84	25	256	HH	01/01
129	903	JHAWANI	PRECIPITATION	C	27	35	84	32	270	HH	02/01
130	904	CHISAPANI GADHI	PRECIPITATION	C	27	33	85	8	1,706	MD	05/01
131	905	DAMAN	CLIMATOLOGY	C	27	36	85	5	2,314	HH	09/01
132	906	HETAUNDA N.F.I.	CLIMATOLOGY	C	27	25	85	3	474	HH	08/01
133	907	AMLEKHGANJ	PRECIPITATION	C	27	17	85	0	396	HH	06/01
134	909	SIMARA AIRPORT	AERONAUTICAL	C	27	10	84	59	130	HH	09/01
135	910	NUGADH	PRECIPITATION	C	27	17	85	10	244	HD	06/01
136	911	PARWANIPUR	AGROMETEOLOGY	C	27	4	84	58	115	HH	01/01
137	912	RAMOLI BAIRIYA	PRECIPITATION	C	27	1	85	23	152	HD	01/01
138	915	KARKHU GAUN	PRECIPITATION	C	27	37	85	9	1,530	HH	12/01
139	918	BIRGANJ	PRECIPITATION	C	27	0	84	52	91	HH	02/01
140	919	MAKWANPUR GADHI	PRECIPITATION	C	27	25	85	10	1,030	MD	12/01
141	920	BELUWA	PRECIPITATION	C	27	30	84	45	274	HH	12/01
142	921	KALAIYA	PRECIPITATION	C	27	2	85	0	140	MD	02/01
143	922	GAUR	CLIMATOLOGY	C	26	46	85	18	90	HH	03/01
144	1001	TIMURE	PRECIPITATION	C	28	17	85	26	1,900	MD	06/01
145	1002	ARU GHAT D. BAZAR	PRECIPITATION	C	28	3	84	49	518	MD	06/01
146	1004	NUWAKOT	CLIMATOLOGY	C	27	55	85	10	1,003	HH	05/01
147	1005	DHADING	PRECIPITATION	C	27	52	84	56	1,420	MD	05/01
148	1006	GUMTHANG	PRECIPITATION	C	27	52	85	52	2,000	MD	07/01
149	1007	KAKANI	AGROMETEOLOGY	C	27	48	85	15	2,064	HH	01/01
150	1008	NAWALPUR	PRECIPITATION	C	27	48	85	37	1,592	MD	06/01

NOTE : ACC.(ACCESSBILITY)
HH : WITHIN HALF(0.5) HOUR WORKING DISTANCE
1D : WITHIN ONE(1) DAY HOUR WORKING DISTANCE
MD : MORE THAN ONE DAYS WORKING DISTANCE

MIN 72
MAX 4,091

Table 5.2 LIST OF METEOROLOGICAL STATIONS (4 / 5)

NO.	INDEX NO.	STATION'S NAME	TYPE OF STATION	REG.	LATI-TUDE			LONGI-TUDE			ELV. (m)	ACC.	ESTABLISHED DATE
151	1009	CHAUTARA	PRECIPITATION	C	27	47		85	43		1,660	HH	07/01
152	1015	THANKOT	PRECIPITATION	C	27	41		85	12		1,630	HH	09/01
153	1016	SARMATHANG	CLIMATOLOGY	C	27	57		85	36		2,625	MD	11/01
154	1017	DUBACHAUR	PRECIPITATION	C	27	52		85	34		1,550	MD	11/01
155	1018	BAUNEPATI	PRECIPITATION	C	27	47		85	34		845	MD	11/01
156	1020	MANDAN	PRECIPITATION	C	27	42		85	39		1,365	MD	07/01
157	1022	GODAVARI	CLIMATOLOGY	C	27	35		85	24		1,400	HH	05/01
158	1023	DOLAL GHAT	PRECIPITATION	C	27	38		85	43		710	HH	07/01
159	1024	DHULIKHEL	CLIMATOLOGY	C	27	37		85	33		1,552	HH	06/01
160	1025	DHAP	PRECIPITATION	C	27	55		85	36		1,240	MD	12/01
161	1027	BAHRABISE	PRECIPITATION	C	27	47		85	54		1,220	HH	12/01
162	1028	PACHUWAR GHAT	PRECIPITATION	C	27	34		85	45		633	HD	01/01
163	1029	KHUMALTAR	AGROMETEOLOGY	C	27	40		85	20		1,350	HH	05/01
164	1030	KATHMANDU AIRPORT	AERONAUTICAL	C	27	42		85	22		1,336	HH	01/01
165	1035	SANKHU	PRECIPITATION	C	27	45		85	29		1,449	HH	09/01
166	1036	PANCHKHAL	AGROMETEOLOGY	C	27	41		85	38		865		11/01
167	1038	DHUNIBESI	CLIMATOLOGY	C	27	43		85	11		1,085	HH	04/01
168	1039	PANIPOKARI (KATHMANDU)	CLIMATOLOGY	C	27	44		85	21		1,335	HH	04/01
169	1043	NAGARKOT	CLIMATOLOGY	C	27	42		85	31		2,163	HH	06/01
170	1049	KHOPASI (PANAUTI)	PRECIPITATION	C	27	35		85	31		1,517	HH	06/01
171	1052	BHAKTAPUR	PRECIPITATION	C	27	44		85	25		1,330	HH	05/01
172	1054	THAMACHIT	PRECIPITATION	C	28	10		85	19		1,847	MD	11/01
173	1055	DHUNCHE	CLIMATOLOGY	C	28	6		85	18		1,982	HH	11/01
174	1057	PANSAYAKHOLA	CLIMATOLOGY	C	28	1		85	7		1,240	MD	01/01
175	1058	TARKE GHYANG	PRECIPITATION	C	28	0		85	33		2,480	MD	01/01
176	1059	CHANGU NARAYAN	PRECIPITATION	C	27	45		85	25		1,543	HH	05/01
177	1060	CHAPA GAUN	PRECIPITATION	C	27	36		85	20		1,448	HH	10/01
178	1062	SANGACHOK	CLIMATOLOGY	C	27	42		85	43		1,327	HH	05/01
179	1063	THOKARPA	PRECIPITATION	C	27	42		85	47		1,750	HD	07/01
180	1071	BUDDHANILAKANTHA	CLIMATOLOGY	C							1,360		02/01
181	1072	PAIGUTANG	CLIMATOLOGY	C	28	13		85	11		4,091		09/01
182	1101	NAGDAHA	PRECIPITATION	C	27	41		86	6		850	MD	01/01
183	1102	CHARIKOT	PRECIPITATION	C	27	40		86	3		1,940	HH	06/01
184	1103	JIRI	AGROMETEOLOGY	C	27	38		86	14		2,003	HH	08/01
185	1104	MELUNG	PRECIPITATION	C	27	31		86	3		1,536	MD	06/01
186	1106	RAMECHHAP	PRECIPITATION	C	27	19		86	5		1,395	MD	04/01
187	1107	SINDHULI GADHI	CLIMATOLOGY	C	27	17		85	58		1,463	HD	06/01
188	1108	BAHUN TILPUNG	PRECIPITATION	C	27	11		86	10		1,417	MD	05/01
189	1109	PATTHARKOT (EAST)	PRECIPITATION	C	27	5		86	40		275	HH	01/01
190	1110	TULSI	PRECIPITATION	C	27	2		86	55		457	MD	12/01
191	1111	JANAKPUR AIRPORT	CLIMATOLOGY	C	26	43		85	58		90	HH	08/01
192	1112	CHISAPANI BAZAR	PRECIPITATION	C	26	55		86	10		165	HH	07/01
193	1115	NEPALTHOK	PRECIPITATION	C	27	27		85	49		1,098	MD	04/01
194	1117	HARIHARPUR GADHI VALLEY	PRECIPITATION	C	27	20		85	30		250	MD	03/01
195	1118	MANUSMARA	CLIMATOLOGY	C	26	53		85	25		100	HH	02/01
196	1119	GAUSALA	PRECIPITATION	C	26	53		85	47		200	HH	02/01
197	1120	MALANGWA	PRECIPITATION	C	26	52		85	34		150	HH	03/01
198	1121	KARMAIYA	CLIMATOLOGY	C	27	7		85	28		131	HH	08/01
199	1122	JALESORE	CLIMATOLOGY	C	26	39		85	47			HH	03/01
200	1202	CHAURIKHARK	PRECIPITATION	E	27	42		86	43		2,619	MD	04/01

NOTE : ACC.(ACCESSBILITY)
HH : WITHIN HALF(0.5) HOUR WORKING DISTANCE
1D : WITHIN ONE(1) DAY HOUR WORKING DISTANCE
MD : MORE THAN ONE DAYS WORKING DISTANCE

MIN 72
MAX 4,091

Table 5.2 LIST OF METEOROLOGICAL STATIONS (5 / 5)

NO.	INDEX NO.	STATIONS NAME	TYPE OF STATION	REG.	LATI-TUDE		LONGI-TUDE		ELV. (m)	ACC.	ESTABLISHED DATE
201	1203	PAKARNAS	PRECIPITATION	E	27	26	86	34	1,982	MD	12/01
202	1204	AISEALUKHARK	PRECIPITATION	E	27	21	86	45	2,143	MD	05/01
203	1206	OKHALDHUNGA	SYNOPTIC	E	27	19	86	30	1,720	1D	12/01
204	1207	NAME BHANJYANG	PRECIPITATION	E	27	12	86	25	1,576	MD	11/01
205	1210	KURULE GHAT	PRECIPITATION	E	27	8	86	25	497	MD	12/01
206	1211	KHOTANG BAZAR	PRECIPITATION	E	27	2	86	50	1,295	MD	05/01
207	1212	PHATEPUR	CLIMATOLOGY	E	26	44	86	51	100	HH	07/01
208	1213	UDAYAPUR GADHI	CLIMATOLOGY	E	26	56	86	31	1,175	HH	07/01
209	1215	LAHAN	CLIMATOLOGY	E	26	44	86	30	136	HH	11/01
210	1216	SIRAHA	PRECIPITATION	E	26	39	86	13	102	HH	06/01
211	1217	KHUMJUNG	PRECIPITATION	E	27	49	86	43	3,750	MD	05/01
212	1219	SALLERI	PRECIPITATION	E	27	30	86	35	2,378	MD	12/01
213	1220	CHIALSA	AGROMETEOLOGY	E	27	31	86	37	2,770	1D	05/01
214	1222	DIKTEL	PRECIPITATION	E	27	13	86	48	1,623	1D	06/01
215	1223	RAJBIRAJ	CLIMATOLOGY	E	26	33	86	45	91	HH	12/01
216	1224	SIRWA	PRECIPITATION	E	27	33	86	23	1,662	MD	05/01
217	1226	BARMAJHIYA	PRECIPITATION	E	26	36	86	54	85	HH	09/01
218	1301	NUM	PRECIPITATION	E	27	33	87	17	1,497	MD	06/01
219	1303	CHAINPUR (EAST)	CLIMATOLOGY	E	27	17	87	20	1,329	HH	07/01
220	1304	PAKHRIBVAS	AGROMETEOLOGY	E	27	3	87	17	1,680		01/01
221	1305	LEGUWA GHAT	PRECIPITATION	E	27	8	87	17	410	MD	07/01
222	1306	MUNGA	PRECIPITATION	E	27	2	87	14	1,317	MD	07/01
223	1307	DHANKUTA	SYNOPTIC	E	26	59	87	21	1,445	HH	06/01
224	1308	MULGHAT	PRECIPITATION	E	26	56	87	20	365	HH	06/01
225	1309	TRIBENI	PRECIPITATION	E	26	56	87	9	143	MD	05/01
226	1311	DHARAN BAZAR	PRECIPITATION	E	26	49	87	17	444	HH	06/01
227	1312	HARAINCHA	PRECIPITATION	E	26	37	87	23	152	HH	04/01
228	1314	TERMATHUM	CLIMATOLOGY	E	27	8	87	33	1,633	HD	05/01
229	1316	CHATARA	PRECIPITATION	E	26	49	87	10	183	HH	06/01
230	1317	CHEPUWA	PRECIPITATION	E	27	46	87	25	2,590	MD	06/01
231	1319	BIRATNAGAR AIRPOART	AERONAUTICAL	E	26	29	87	16	72	HH	07/01
232	1320	TARAHARA	AGROMETEOLOGY	E	26	42	87	16	200	HH	07/01
233	1321	TUMLINGTAR	PRECIPITATION	E	27	17	87	13	303	1D	05/01
234	1322	MACHUWAGHAT	PRECIPITATION	E	26	58	87	10	158	MD	05/01
235	1323	DHARAN BRITISH CAMP	CLIMATOLOGY	E	26	47	87	17	400	HH	08/01
236	1324	BHOJPUR	AGROMETEOLOGY	E	27	11	87	3	1,595	1D	08/01
237	1325	DINGLA	PRECIPITATION	E	27	22	87	9	1,190	MD	05/01
238	1403	LUNGTHUNG	PRECIPITATION	E	27	33	87	47	1,780	MD	07/01
239	1404	TAPLETHOK	PRECIPITATION	E	27	29	87	47	1,383	MD	07/01
240	1405	TAPLEJUNG	SYNOPTIC	E	27	21	87	40	1,732	1D	07/01
241	1406	MEMENG JAGAT	PRECIPITATION	E	27	12	87	56	1,830	MD	07/01
242	1407	ILAM TEA ESTATE	AGROMETEOLOGY	E	26	55	87	54	1,300	HH	03/01
243	1408	DAMAK	PRECIPITATION	E	26	43	87	40	163	HH	03/01
244	1409	ANARMANI BIRTA	PRECIPITATION	E	26	38	87	59	122	HH	03/01
245	1410	HIMALI GAUN	PRECIPITATION	E	26	53	88	2	1,654	HH	02/01
246	1411	SOKTIM TEA ESTATE	CLIMATOLOGY	E	26	48	87	54	530	HH	06/01
247	1412	CHANDRA GADHI	PRECIPITATION	E	26	34	88	3	120	HH	02/01
248	1415	SANISCHARE	PRECIPITATION	E	26	41	87	58	168	HH	01/01
249	1416	KANYAM TEA ESTATE	CLIMATOLOGY	E	26	52	88	4	1,678	HH	04/01
250	1419	PHIDIM (PANCHTHER)	CLIMATOLOGY	E	27	9	87	45	1,205	HH	07/01
251	1420	DOVAN	PRECIPITATION	E	27	21	87	36	763	MD	07/01
252	1421	GAIDA (KANKAI)	CLIMATOLOGY	E	26	30	87	54	143	HH	02/01

NOTE : ACC.(ACCESSBILITY)
HH : WITHIN HALF(0.5) HOUR WORKING DISTANCE
1D : WITHIN ONE(1) DAY HOUR WORKING DISTANCE
MD : MORE THAN ONE DAYS WORKING DISTANCE

Table 5.3 LIST OF HYDROLOGICAL STATIONS (1 / 5)

NO.	ST. NO.	NAME OF RIVER	NAME OF SITES	LATI-TUDE			LONGI-TUDE			ELV. (m)	DRAREA (sq km)	INSTRU-MENT			START OF RECORD
1	120	CHAMELIA	KARKALE GAON	29	40	20	80	33	30		1,150				65/01/01
2	150	MAHAKALI	PANCHESHWOR	29	26	45	80	15	30			C	R		
3	169.8	SURNAGAD	GUJAR GAON	29	31	0	80	35	0		(66)	C			
4	190.5	KANDRA KHOLA	AMSARA	28	36	0	80	56	0		(313)				
5	240	KARNALI	ASARA GHAT	28	57	10	81	26	30	629	19,260	C	R	S	61/01/01
6	250	KARNALI	BENIGHAT	28	57	40	81	7	10	320	21,240	C	R		63/02/01
7	251	SETI	CHAINPUR	29	33	30	81	12	40		2,040	C			
8	255	BHDHI GANGA	KAKARSANT	29	11	0	81	13	0		1,340	C			78/04/28
9	259.2	SETI	GOPAGHAT GAON	29	18	0	80	46	30		4,420	C			
10	260	SETI	BANGA NEAR BELGAON	28	58	40	81	8	40	328	7,460	C	R	S	63/02/06
11	262	TULI GAD	KHANAYATAL	28	56	0	80	54	0	314	896	C	R		65/06/17
12	280	KARNALI	CHISAPANI	28	38	40	81	17	30	191	42,890	C	R	S	62/01/01
13	285	MOHANA	KALAKUNTA	28	27	0	81	0	30		(623)				76/04/22

NOTE : INSTRUMENT

C : CABLEWAY
R : RECORDING WATER LEVEL GAUGE (FLOAT-TYPE)
PR: RECORDING WATER LEVEL GAUGE (PRESSURE-TYPE)
S : SEDIMENT SAMPLER

Table 5.3 LIST OF HYDROLOGICAL STATIONS (2 / 5)

NO.	ST. NO.	NAME OF RIVER	NAME OF SITES	LATI-TUDE			LONGI-TUDE			ELV. (m)	DRAREA (sq km)	INSTRU-MENT			START OF RECORD
1	205	KHARPU KHOLA	KHARPU	29	57	0	81	52	0		1,310				78/05/14
2	206	HUMLA KARNALI	BIHI CHHARA	29	38	0	81	52	0		(8,447)				79/06/17
3	208	MUGU KARNALI	SURKHET	29	37	0	81	52	0		5,300	C			79/06/13
4	209	KAWADI KHOLA	KAWADI GHAT	29	36	16	81	45	28		795				
5	210	RARA DAHA	NIZAL	29	31	0	82	4	0		1,150				65/11/08
6	215	HUMLA KARNALI	THULDADA	29	9	0	81	36	0		15,200	C			66/02/06
7	220	TILA NALA	NAGINA	29	12	0	81	55	0		1,870	C			64/03/19
8	225	SINJA KHOLA	DIWARE	29	12	0	81	55	0		824	C			64/03/17
9	230	TILA NADI	SETIGHAT	29	8	0	81	36	0		3,470	C			64/03/08
10	241	LOHARE KHOLA	TALLO DUNGESWAT	28	41	0	81	36	0		1,060	C			65/05/24
11	245	CHHAMGHAT KHOLA	GITACHAUR	28	56	0	81	41	30		(108)	C			78/03/20
12	265	THULO BHERI	RIMNA	28	42	30	82	17	30		6,720	C			72/06/18
13	267	SANO BHERI	SIMLI GHAT	28	39	30	82	21	30		2,620	C			76/06/18
14	269.5	BHERI NADI	SAMAIJI GHAR									C	PR		
15	270	BHERI	JAMU	28	45	20	81	21	0	246	12,290	C	R	S	63/01/23
16	284	SARDA KHOLA	SHYALPANI - SITA PALL	28	22	30	82	11	45		295				77/06/17
17	286	SARADA KHOLA	DARADHUNGA	28	17	58	82	1	30		816	C	R	S	72/01/01
18	287	KAURIALA KARNALI	SATTAR FARM	28	24	30	81	5	0						80/03/17
19	288	GERUWA KARNALI	KOTHIYA GHAT	28	22	30	81	12	0		(14,853)				80/03/18
20	289.5	GOHAR KHOLA	SIRCHAUR GAON	28	9	15	82	22	45			C			77/06/21
21	289.95	BABAI NADI	CHEPANG									C	R		
22	289.9	BABAI NADI	GANGATA												
23	291	BABAI NADI	BHADA												
24	327	LUNGRI LHOLA	KHUNGREE GAON	28	13	30	82	42	30		467	C			76/12/26
25	330	MARI LHOLA	NAYAGAON	28	4	20	82	48	0	536	1,980	C			64/01/01
26	333	ARUN KHOLA	DEVISTAN	28	2	0	82	45	30		136	C			68/01/01
27	339.5	JHIMRUK KHOLA	TIGRA GAON	28	3	0	82	49	40		683	C			71/05/22
28	350	RAPTI	BAGASOTI GAON	27	54	0	82	51	0	381	3,380	C	R	S	75/05/08
29	350.5	RANGSING KHOLA	TINKHANNE GAON	27	47	30	82	49	0		(92)	C			83/01/03
30	360	RAPRI	JALKUNDI	27	56	50	82	13	30	218	5,150	C	R	S	64/04/08
31	385.2	RAPTI RIVER	FARINDA												

NOTE : INSTRUMENT

C : CABLEWAY
R : RECORDING WATER LEVEL GAUGE (FLOAT-TYPE)
PR: RECORDING WATER LEVEL GAUGE (PRESSURE-TYPE)
S : SEDIMENT SAMPLER

Table 5.3 LIST OF HYDROLOGICAL STATIONS (3 / 5)

NO.	ST. NO.	NAME OF RIVER	NAME OF SITES	LATI-TUDE			LONGI-TUDE			ELV. (m)	DRAREA (sq km)	INSTRU-MENT			START OF RECORD
1	387.4	DUMRE KHOLA	KALIMATI	27	47	47	83	32	9	595	90	C			80/06/18
2	387.5	MADI TINAU	CHARCHARE	27	47	29	83	33	8	570	103	C	R		80/06/17
3	387.8	JHUMSA KHOLA	DUMAHI BARI	27	45	0	83	30	46	335	99	C			85/02/15
4	390	TINAU KHOLA	BUTWAL	27	42	10	83	27	50	184	554	C			63/12/09
5	403	KALI GANDAKI	JOMSOM	28	47	30	83	45	0		(3,060)				69/06/07
6	404.6	KALI GANDAKI	KALIPUL BENI	28	21	30	83	34	30		(4,581)				71/04/05
7	404.7	MYAGDI KHOLA	MANGLA GHAT	28	21	30	83	32	0		(1,112)	C			75/05/19
8	406.5	MODI KHOLA	NAYAPUL NEAR JHAPRE BAGAR	28	13	30	83	42	15		(635)	C			75/05/25
9	409.5	SETI KHOLA	SETI BENI	28	0	40	83	37	10		(138)				76/02/22
10	410	KALI GANDAKI	SETI BENI	28	0	30	83	36	10	546	6,630	C	R	S	64/02/21
11	413.2	DANAB KHOLA										C			
12	415	ANDHI KHOLA	DUMRICHAUR ANDHIMUHAN	27	58	20	83	35	20	543	476	C			64/04/06
13	416.2	DARAM KHOLA	WAMITAKSAR	28	11	45	83	18	15		(239)	C			78/12/18
14	417	BADIGAD KHOLA	RUDRABENI GULMI	27	58	20	83	28	10		1,990	C			67/05/24
15	419.1	KALI GANDAKI	ANSIGH - ANDHI GHAT									C			89/04/13
16	428	MARDI KHOLA	LAHACHOK	28	18	30	83	55	30		160	C			70/06/07
17	430	SETI	PHOOLBARI	28	14	0	84	0	0	830	582	C			64/01/01
18	438	MADI	SHISA GHAT	28	6	0	84	14	0		858	C			73/02/08
19	439.3	KHUDI KHOLA	KHUDI BAZAR	28	17	15	84	21	45		(151)	C			81/07/04
20	439.4	DORDI KHOLA	AMOTE BAGAR - SERA BESI	28	10	45	84	27	30		(341)	C			78/02/09
21	439.7	MARSYANGDI	BIMAL NAGAR	27	57	0	84	25	48	354	(4,088)	C	R	S	87/03/31
22	440	CHEPE KHOLA	GARAM BESI	28	3	41	84	29	23	442	308	C	PR		63/11/20
23	441	DARAUNDI KHOLA	NAYASANGHU GORKHA	28	1	0	84	35	15		386	C			67/10/13
24	445	BURHI GANDAKI	ARUGHAT	28	2	37	84	48	59	485	4,270	C	R	S	63/11/28
25	445.3	ANKHU KHOLA	ANKHU BRIDGE	27	58	20	84	49	10		768	C			67/01/01

NOTE : INSTRUMENT

C : CABLEWAY
R : RECORDING WATER LEVEL GAUGE (FLOAT-TYPE)
PR: RECORDING WATER LEVEL GAUGE (PRESSURE-TYPE)
S : SEDIMENT SAMPLER

Table 5.3 LIST OF HYDROLOGICAL STATIONS (4 / 5)

NO.	ST. NO.	NAME OF RIVER	NAME OF SITES	LATI-TUDE			LONGI-TUDE			ELV. (m)	DR. AREA (sq. km)	INSTRU-MENT			START OF RECORD
1	420	KALI GANDAKI	KOTAGAON SHRINGE	27	45	0	84	20	50	198	11,400	C	R		64/04/15
2	446.2	LANGTANG KHOLA	SHYAPRUBESI	28	9	30	85	20	45		(540)	C			
3	446.3	TRISULI KHOLA	DHUNCHE	28	7	10	85	17	40		49	C	R		63/01/01
4	446.8	PHALANKHU KHOLA	BETRAWATI	27	58	25	85	11	15	630	162				69/04/24
5	447	TRISULI	BETRAWATI	27	58	8	85	11	0	600	4,110	C	R	S	67/04/01
6	447.4	TADI KHOLA	RAUTAR NUWAKOT	27	55	0	85	17	10		254				
7	447.9	LIKHU KHOLA	PATTAWARI NUWAKOT	27	53	30	85	14	45		(145)				
8	448	TADI KHOLA	TADIPUL BELKOT	27	51	35	85	8	18	475	653				68/06/14
9	449.9	TRISULI	MUGLING	27	51	0	84	34	30						
10	449.95	TRISULI	BHORLETAR	27	49	0	84	26	45		(14,500)	C			82/02/26
11	450	NARAYANI	NARAYAN GHAT	27	42	30	84	25	50	180	31,100	C	R	S	62/02/10
12	460	RAPTI	RAJAIYA	27	26	30	84	58	15	332	579	C			63/01/01
13	465	MANAHARI KHOLA	MANAHARI	27	33	0	84	48	10	305	427	C	R		63/08/13
14	470	LOTHAR KHOLA	LOTHAR	27	35	40	84	43	0	338	169	C			63/11/30
15	505	BAGMATI	SUNDARIJAL	27	46	30	85	25	40	1,600	17	C	R		62/12/07
16	507	NAGMATI	SUNDARIJAL	27	46	20	85	26	10	1,660	13				63/11/01
17	510	SIALMATI	SHYAMDADO	27	46	10	85	25	10	1,660	3				63/11/01
18	511	DHAKAL KHOLA	GAGALGAU	27	44	45	85	26	15						
19	525.5	MANAHARA RIVER	SHAKYU SALMUTAR												
20	530	BAGMATI	GAURI GHAT	27	42	30	85	21	0	1,300	68				64/11/15
21	536.2	BISHNUMATI KHOLA	BUDHANILKANTHA	27	46	49	85	21	32	1,454	4				68/05/27
22	548	NAKHU KHOLA	NAKHU JAIL NEAR PATAN	27	39	40	85	18	30		56				62/01/01
23	550.05	BAGMATI	KHOKANA										PR		
24	586	BAGMATI	RAI GAON												
25	589	BAGMATI	PANDHERA DOBHAN	27	6	20	85	28	30	180	2,700	C	R	S	79/01/28
26	610	BHOTE KOSI	BARABISE	27	47	10	85	53	20	840	2,410				65/02/17
27	612	SUN KOSI	BARABISE	27	46	30	85	54	30		(84)				
28	620	BALEPHI KHOLA	JALBIRE	27	48	20	85	46	10	793	629	C			63/12/25
29	625	SUN KOSI	DOLALGHAT	28	38	30	85	43	0		(1,375)	C			
30	627.5	MELAMCHI KHOLA	HELAMBU	28	2	30	85	32	0						
31	629.1	INDRAWATI	DOLAL GHAT	27	38	20	85	42	30		1,225	C			
32	630	SUN KOSI	PACHUWAR GHAT	27	33	30	85	45	10	589	4,920	C			64/03/26
33	640	ROSI KHOLA	PANAUTI	27	34	50	85	30	50	1,480	87				63/10/17
34	641	ROSI KHOLA	LOLDKHOLA												
35	647	TAMAKOSI	BUSTI	27	38	5	86	5	12	849	2,753	C	R		70/01/14
36	650	KHIMTI KHOLA	RASNALU VILLAGE	27	34	30	86	11	50	1,520	313	C			64/04/06
37	652	SUNKOSI	KHURKOT	27	20	0	86	0	0	455	10,000	C			67/07/01
38	660	LIKHU KHOLA	SANGUTAR	27	20	10	86	13	10	543	823	C			64/03/24

NOTE : INSTRUMENT

C : CABLEWAY
R : RECORDING WATER LEVEL GAUGE (FLOAT-TYPE)
PR: RECORDING WATER LEVEL GAUGE (PRESSURE-TYPE)
S : SEDIMENT SAMPLER

Table 5.3 LIST OF HYDROLOGICAL STATIONS (5 / 5)

NO.	ST. NO.	NAME OF RIVER	NAME OF SITES	LATI-TUDE			LONGI-TUDE			ELV. (m)	DR AREA (sq. km)	INSTRU-MENT			START OF RECORD
1	592	BAGMATI	BRAMHAPURI	26	45	30	85	20	0		(13,790)				Nov-85
2	598	KAMALA	CHISAPANI	26	25	15	86	10	30		(1,595)				Nov-85
3	599	KAMALA	INARWA	26	36	45	86	9	0						
4	600.1	ARUN	UWA GAON	27	36	0	87	20	6	1,294	26,750	C	R	S	11-May-72
5	600.05	BARUN KHOLA	SEKSILA HATIYA	27	41	0	87	21	0	1,500	352				22-Dec-86
6	601.8	PANGTHA KHOLA	KURLE BESI	27	24	0	87	13	30		(26)				Sep-83
7	601.9	PANGMA KHOLA	KURLE BESI	27	24	0	87	12	45		(38)				Sep-83
8	602	SABHAYA KHOLA	TUMLINGTAR	27	18	20	87	13	15		375	C	R		02-Jan-74
9	602.5	HINWA KHOLA	PIPLETAR	27	17	45	87	13	30		110	C			75
10	604	ARUN	LEGUWA GHAT	27	9	0	87	16	30		(4,183)				01-Jun-68
11	604.5	ARUN	TURKEGHAT	27	20	0	87	11	30	414	28,200	C	R		23-May-75
12	606	ARUN	SIMLE	26	55	30	87	9	30		(5,173)	Br			80
13	665	SUN KOSI	AHRKAPUR (TOKSELGHAT)	27	10	30	86	22	0		(8,736)	C			20-Feb-86
14	668.4	TAKTOR KHOLA	BENI	27	31	45	86	33	30	2,350	(87)	Br			76
15	668.5	SOLUA KHOLA	SALME	27	30	30	86	33	15	1,800	(324)	Br			76
16	670	DUDH KOSI	RABUWA BAZAR	27	16	0	86	39	50	460	4,100	C	R	S	10-Mar-64
17	680	SUN KOSHI	KAMPUGHAT	26	52	30	86	49	20	200	17,600				28-Jun-65
18	681	SUN KOSHI	HAMPUACHUWAR	26	55	15	87	8	45		(14,682)	C			Jul-76
19	684	TAMUR	MAJHITAR	27	9	30	87	42	45		(4,076)	C			82
20	688.7	NIBUWA KHOLA	DHANKUTA	26	59	0	87	23	15		(28)				Sep-83
21	689	TANKHUWA KHOLA	SIRETAR NEAR DHANKUTA	26	58	30	87	22	15		51				01-Jan-64
22	690	TAMUR	MULGHAT	26	55	50	87	19	45	276	5,640	Br	PR	S	11-Mar-65
23	691	TAMUR	TRIBENI	26	55	0	87	10	0		(5,146)	C			Jun-81
24	695	SAPTA KOSHI	CHATARA-KOTHU	26	52	0	87	9	30	140	54,100	C		S	01-Jan-77
25	728	MAI KHOLA	RAJDWAIL	26	52	45	87	55	45		377	C		S	01-Jan-83
26	730	PUWA KHOLA	SAJBOTE (ILAM)	26	55	0	87	54	40	802	107	C			18-Jan-65
27	738	DEO MAI KHOLA	ANGDANG	26	54	0	87	46	15		(199)	C			82
28	795	KANKAI MAI	MAINACHULI	26	41	12	87	52	44	125	1,148	C	R		01-May-71
29	799	KANKAI	KUMARKHOD - JHAPA												30-Oct-87

NOTE : INSTRUMENT

C : CABLEWAY
R : RECORDING WATER LEVEL GAUGE (FLOAT-TYPE)
PR: RECORDING WATER LEVEL GAUGE (PRESSURE-TYPE)
S : SEDIMENT SAMPLER

Table 5.4 LIST OF LABORATORY INSTRUMENTS

Regional Office	Location	Instrument	Q'ty	Manufacture (Country)	Condition	Remarks
Far-Western	Chisapani (Kalnali Multi Purpose Project)	Electric Oven (Circulation type)	1	Mitamura Riken Kogyo (Japan)	Working	Max. 250°C AC 220 V, 50 Hz
		Electric Scale	1	Mettler P1200	Working	Max. 1200 g, 0.1 g unit
		ditto	1	Mettler H54AR	Working	Max 160 g, 0.01 mg unit
Mid-Western	Ghorai	Electric Oven (Circulation type)	1	Mitamura Riken Kogyo (Japan)	Working	Max. 250° AC 220 V, 50 Hz
		Balance	1	Weignbird (India)	Not Good	
Western	Pokhara	Electric Oven (Circulation type)	1	Mitamura Riken Kogyo (Japan)	Under Repair	
		Balance	1	(India)	Not Good	
		Electric Scale	1	Mettler H54AR	Working	Max. 160 g, 0.01 mg unit
Central	Kathmandu	Electric Oven (Convention type)	1	Sanyo Elect. (Japan)	Working	
		Electric Scale	1	Mettler P2000	Working	Max. 2000 g, 0.1 g unit
		ditto	1	Mettler H31AR	Working	Max. 160 g, 0.1 mg unit
		Tracing Equip.	1 L.C.		Working	Snow & Glacier Project
Eastern	Dharan	Electric Oven	2	Mitamura Riken Kogyo (Japan)	Under Repair	
		Balance	1	(India)	Not Good	Max. 1110 g, 0.1 g unit
		Electric Scale	1	Mettler H54AR	Working	Max. 160 g, 0.01 mg unit

Table 5.5 LIST OF WORKSHOP INSTRUMENTS

(1) Meterological Workshop

Name of instrument/ machine	Q'ty	Manufacture (Country)	Year of purchase (Suplied by)	Condition	Remarks
Bench Lathe Machine	1	Luna AB (Sweden)	1984 (WMO Project)	Good	Making different type of spare parts (shaving, making hole, etc.) AC 220 V, 50 Hz
Bench Drill Machine	1	ditto	1984 (WMO Project)	Good	Drilling holes AC 220 V, 50 Hz
Grinding Machine	1	BERGEON (Swizerland)	1970 (UNDP Project)	Good	AC 220 V, 50 Hz
Small Bench Lathe Machine	1	ditto	1970 (UNDP Project)	Good	Making small type of spare parts such as clock AC 220 V, 50 Hz
Small Drilling Machine	1	ditto	1970 (UNDP Project)	Good	ditto
3466A Digital Multimeter	2	Hewlett Packard (USA)	1984 (WMO Project)	Good	0.1 mV to 1000 V (4.5 digit) AC 220 V, 50 Hz
Temperature Test Cabinet	1	Theodor Friedrich & Co. (Germany)	1984 (WMO Project)	Good	For calibration of thermograph Working range: -25°C - 100°C AC 220 V, 50 Hz
Humidity Chamber	1	ditto	1984 (WMO Project)	Good	For Calibration of hygrograph Working range: 15 - 95% AC 220 V, 50 Hz
Vacuum/Pressure Test Cabinet	1	ditto	1984 (WMO Project)	Good	For calibration of pressure gauge Working range: 50 - 1000 hPa AC 220 V, 50 Hz
Clear-View Testing Chamber	1	ditto	1984 (WMO Project)	Good	For calibration of thermometer Working range: -28°C - 60°C AC 220 V, 50 Hz

(2) Meterological Workshop

Drilling Machine Type KDS-6	1	King-Kong Ind. Co. Ltd. (Taiwan)	1985 (UNDP Project)	Good	AC 220 V, 50 Hz
Grinding Machine	1	T-T Tools (Denmark)	1985 (UNDP Project)	Good	AC 220 V, 50 Hz
Vench Vice	1	(Germany)	1985 (UNDP Project)	Good	
Compact Air Luna	1	Bologna (Italy)	1985 (UNDP Project)	Good	Dust cleaning, painting AC 220 V, 50 Hz
Multi meter KEW	1	Kyoritu Elect. Inst. Works, Ltd. (Japan)	1985 (UNDP Project)	Good	

Table 5.6 NUMBER OF STAFF IN CENTRAL OFFICE

Year: 1991

	Position		Level	Others	Forecasting Division	Climatological Division	Hydrological Division	Other Technical Services	Snow & Glacier	Total
1	Director General		TGI	1	0	0	0	0	0	1
2	Chief Forecaster		TGI	0	1	0	0	0	0	1
3	Chief Meteorologist		TGI	0	0	1	0	0	0	1
4	Chief Hydrologist		TGI	0	0	0	2	0	0	2
5	Senior Meteorologist		TGII	0	1	2	0	1	0	4
6	Senior Hydrologist		TGII	0	0	0	2	0	1*	3
7	Senior Electrical Engineer		TGII	0	0 (1)	0	0	0	0	0 (1)
8	Divisional Hydrologist		TGII	0	0 (1)	0	1 (4)	0	1	2 (6)
9	Divisional Meteorologist		TGII	0	5	0	0	1	0	6
10	Divisional Chemist		TGII	0	0	0	0	1	0	1
11	Divisional Electrical Engineer		TGII	0	0 (2)	0	0	0	0	0 (2)
12	Meteorologist		TGIII	0	3 (9)	3 (6)	0	1 (2)	1	8 (18)
13	Hydrologist		TGIII	0	0	0	1 (6)	1 (2)	1	3 (9)
14	Electrical Engineer		TGIII	0	1	0	0	0	0	1
15	Chemist		TGIII	0	0	0	0	2	0	2
16	Statistician		TGIII	0	0	0	0	1	0	1
17	Senior Hydro-Meteorological Assistant		TNGI	0	21 (24)	0	0	3	8	32 (35)
18	Senior Meteorological Assistant		TNGI	0	0	9 (14)	0	0	0	9 (14)
19	Senior Hydrological Assistant		TNGI	0	0	0	11 (12)	0	0	11 (12)
20	Data Supervisor		TNGI	0	0	0	0	1	0	1
21	Overseer		TNGI	0	0	0	0	2	0	2
22	Draftman		TNGI	0	0	0	0	2	0	2
23	Junior Hydro-Meteorological Assistant		TNGII	0	7 (8)	0	0	5	0	12 (13)
24	Administration ClerK		TNGII	0	0 (1)	0	0	0	0	0 (1)
25	Lab. Technician		TNGII	0	0	0	0	2	0	2
26	Assist Data Pancher		TNGII	0	0	0	0	1 (2)	0	1 (2)
27	Assistant		TNGIII	0	1	0	0	0	0	1
28	Field Assistant		TNGIII	0	0	0	0	0	4 (6)	4 (6)
29	Instrument Mechanist		TNGIII	0	0	0	0	5	0	5
30	Junior Assistant		TNGIII	0	0	0	0	2	0	2
31	Junior Data Pancher		TNGIII	0	0	0	0	2	0	2
	(Technician)	ACTUAL		1	40	15	17	33	16	122
	SUB-TOTAL	CAPACITY		1	55	23	26	36	18	159
32	Divisional Administration Officer		AGII	1	0	0	0	0	0	0
33	Administration Officer		AGIII	1	0	0	0	0	0	0
34	Accountant		AGIII	1	0	0	0	0	0	0
35	Senior Assistant Accountant		ANGI	4	0	0	0	0	0	0
36	Store Assistant		ANGI	1	0	0	0	0	0	0
37	Junior Accountant		ANGI	2	0	0	0	0	0	0
38	Typist		ANGI	3	0	0	0	0	0	0
39	Administration Assistant		ANGII	1 (2)	0	0	0	0	0	0
40	Store Assistant		ANGII	1	0	0	0	0	0	0
41	Assistant Accountant		ANGII	1	0	0	0	0	0	0
42	Administration Assistant		ANGIII	2	0	0	0	0	0	0
43	Peon/Chawkidar/Kuchikar		-	16	7	0	0	0	0	0
TOTAL		ACTUAL		35	47	15	17	33	16	163
		CAPACITY		36	62	23	26	36	18	201

Level;
T: Technical
A: Administrative
G: Gazetted
NG: Non Gazetted

Table 5.7 NUMBER OF STAFF IN REGIONAL OFFICE

YEAR : 1991

REGION			FAR-WESTERN					MID-WESTERN				WESTERN			CENTRAL		EASTERN					Total
POST		Level	Regional Office	SYNOPTIC STATION			Hydro Station	Regional Office	SYNOPTIC STATION			Regional Office	SYNOPTIC STATION		Regional Office	Synoptic Station (Simara)	Regional Office	SYNOPTIC STATION				
				Dipayal	Dadeldhura	Dhangadhi			Surkhet	Jumla	Dang		Pokhara	Bhairahawa				Dhankuta	Okhaldhunga	Taplejung	Biratnagar	
1 Senior Hydrologist		TG2	0	0	0	0	0	1*	0	0	0	1*	0	0	0	0	1*	0	0	0	0	3
2 Senior Meteorologist		TG2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
3 Hydrologist		TG3	1(2)	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	5(6)
4 Meteorologist		TG3	0(1)	0	0	0	0	0(1)	0	0	0	1	0	0	1	0	1	0	0	0	0	3(5)
5 Senior Hydro-meteorological Assistant		TNG1	3(4)	1	1	1	1	2	1	1	1	3	1	1	3	1	5(6)	1	1	0(1)	1	29(32)
6 Silt Analyst		TNG1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	3
7 Junior Hydro. Meteo. Assistant		TNG2	3(1)	1	0(1)	1	2(3)	1(4)	1	1(3)	1(3)	4(7)	0(1)	1	5	0(1)	3(8)	1	1(2)	1	1	28(51)
8 Field Assistant		TNG3	2	1	1	1	1	3	1	1	1	3	1	1	2	1	2(3)	1	1	1	1	26(21)
9 Lab. Boy		TNG4	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	3
(Technician)	ACTUAL		10	3	2	3	4	10	3	3	3	15	2	3	13	2	15	3	3	2	3	102
SUB TOTAL	CAPACITY		16	3	3	3	5	14	3	5	5	18	3	3	13	3	22	3	4	3	3	132
1 Driver		-	0(1)	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	3(4)
2 Senior Administration Assistant		ANG1	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0(1)	0	0	0	0	4(5)
3 Senior Store Assistant		ANG1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
4 Accountant		ANG1	1	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	5
5 Administration Assistant		ANG2	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	3
6 Assistant Accountant		ANG2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
7 Store Assistant		ANG2	0(1)	0	0	0	0	0(1)	0	0	0	0(1)	0	0	1	0	2	0	0	0	0	3(6)
8 Typist		ANG3	1(2)	0	0	0	0	0(1)	0	0	0	0(1)	0	0	0(1)	0	0(1)	0	0	0	0	1(6)
9 Peon		-	5	0	0	0	2	0(1)	0	0	0	1	0	0	1	0	1	0	0	0	0	10(11)
10 Chowkidar		-	1	1	1	1	2	2	1	1	1	2	1	1	2	1	1(3)	1	1	1	1	23(25)
TOTAL	ACTUAL		19	4	3	4	8	16	4	4	4	22	3	4	21	3	22	4	4	3	4	156
	CAPACITY		28	4	4	4	9	23	4	6	6	27	4	4	22	4	33	4	5	4	4	199
German Development Worker			0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	4

NOTE: ( ) : Number of capacity
* : Act for

Level: T: Technician
G: Gazetted
NG: Non Gazetted